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MUNICIPAL WORK IN INDIA.

MUNICIPAL WORK IN INDIA;

OR,

HINTS ON

SANITATION—GENERAL CONSERVANCY
AND IMPROVEMENT IN MUNICIPALITIES, TOWNS, AND
VILLAGES.

BY

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VICE-CHAIRMAN OF THE MUNICIPALITY OF THE SUBURBS OF CALCUTTA.

CALCUTTA:

THACKER, SPINK, AND CO.

1881.

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TO
FREDERICK BARNES PEACOCK, ESQ.,
BENGAL CIVIL SERVICE,
FORMERLY MAGISTRATE OF THE TWENTY-FOUR PERGUNNAHS, AND
EX-OFFICIO CHAIRMAN OF THE MUNICIPALITY OF
THE SUBURBS OF CALCUTTA,
THIS VOLUME
IS INSCRIBED IN RESPECTFUL RECOGNITION OF THE INTEREST TAKEN
BY HIM IN ALL QUESTIONS OF MUNICIPAL IMPROVEMENT,
AND IN GRATEFUL REMEMBRANCE OF MANY KIND-
NESSES RECEIVED AT HIS HANDS BY

THE AUTHOR.

PREFACE.

To indicate all the numerous insanitary conditions of Indian towns and villages, varying as they necessarily do according to local circumstances, the habits peculiar to the people of different districts, and the amount of sanitary supervision to which they are subjected, would require much more space than could be devoted to the subject in a work of this kind, and a much deeper knowledge of sanitary science than the author can pretend to. It will be sufficient to point out the principal of them, their causes, their effects, and, so far as may lie within the usually limited means of mofussil municipal bodies or other local authorities, their remedy.

In dealing with the following subjects the author desires to give his readers the results of an experience gained during a period of upwards of twenty years' residence in India, and especially during his twelve years' incumbency as chief executive officer of the largest mofussil municipality in Bengal;—a municipal district which had been described by the Army Sanitary Commission as “a permanent focus of malaria and contagion,” the environs of a city the inhabitants of which a well-known medical authority, some years

ago, declared to be "living for the past half century at fearful disadvantages, in the midst of scandalous sanitary arrangements, and in the concentrated atmosphere of its own excrement and refuse;"—a suburban district of which a late Sanitary Commissioner of Bengal wrote in 1868 (the year in which the author's official connection with it commenced),—"It is very evident that interference on the part of Government is much required, indeed, all the suburbs are in a most uncared for state, and I hope the matter will be speedily taken up;"—and of which, ten years later, his successor reported, that, "judging from the remarks of Dr. D. B. Smith in his first Sanitary Report of Bengal in 1868, the Municipality is to be congratulated on the great improvements effected since then. Much however remains to be done; all these improvements cannot be effected at once, but I am encouraged to suggest them, because *so much has been done* that I am sure further progress is not only possible but comparatively easy."

Having had, in addition to the ordinary duties of the head of a Municipal office, to perform, unaided, throughout a series of years, the duties ordinarily appertaining to a health officer and to an executive engineer, the writer has, of necessity, been brought into constant practical contact with the subjects of which he has treated in these pages, and has had, so far as in him lay, and means were available, to educate himself to keep pace with the growing sanitary requirements of the age. Whilst fully conscious, therefore, of the force of Dryden's trite remark, "that he who purposes to be an author should first be a student," he has him-

self, whilst comparatively a novice in sanitation and questions of engineering, so often felt the want of some book of reference on the multifarious matters composing the daily work of a municipal official in this country, that he ventures to hope that the results of his experience and study of these subjects may be of use to others similarly situated, but whose opportunities may not perhaps have been so great of acquiring the simple and practical knowledge required for the efficient conduct of their duties.

Since the days of long afflicted and patient Job whose aspiration was "Oh! that mine adversary would write a book," no man who is bold enough to venture on authorship, in however unpretending a manner, may hope to escape criticism, for

" Those fierce inquisitors of wit
The critics spare no flesh that ever writ."—*Butler*.

Yet do I deprecate the criticism of the Medical Profession and the Civil Engineer. These pages do not presume to be for their guidance, but for that of simple people like myself who have to deal with common nuisances, combat common dangers, and construct common necessary structures with simple means, little knowledge, and small expenditure; unless, peradventure the medical man, whose duties may sometimes extend to general municipal supervision, may find some simple hint on matters foreign to his own profession, or the Civil Engineer, similarly situated, may find some light thrown on a question of sanitation with which he is brought into contact. I have carefully avoided putting forward any crude theories of

my own, remembering always that "a little knowledge is a dangerous thing;" but where I have stated the results of my own experience, I have supported them with the opinions and experience of the most reliable modern authorities to which I have had access, and knowing from experience how inaccessible sanitary literature is to the majority of officials on the same footing as myself, I have not hesitated to give ample quotations and extracts from the published works or manuscript writings of known sanitary authorities and well-known and experienced Indian medical men, to which I have had occasion or opportunity to refer.

I trust, therefore, that these pages will be found useful to those who, without professional training or special education for the duties of sanitary supervision and minor works of engineering, are placed in positions where such duties have to be undertaken by them; and if I have not been so successful as I could desire, it must never be forgotten that

"No part of conduct asks for skill more nice,
Though none more common than to give advice."

R. C. S.

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MUNICIPAL WORK IN INDIA.

CHAPTER I.

“ — He that goeth about to persuade a multitude that they are not so well governed as they ought to be, shall never want attentive and favourable hearers ; because they know the manifold defects whereunto every kind of regimen is subject : but the secret lets and difficulties which in public proceedings are innumerable and inevitable, they have not ordinarily the judgment to consider.”—*Hooker*.

As the improvement of our Municipalities is the main object of this book, it will not be out of place if a few introductory pages are devoted to a consideration of what our municipal system is, how far it is suited to the circumstances of the country and the idiosyncrasy of the people, and the causes why municipal bodies generally do not succeed better in their attempts to improve the condition of the towns and villages over which they preside. It is not uncommonly asserted that municipal institutions are foreign to and unsuited to the country, but those who thus argue ignore alike tradition, history, and facts. On the contrary, municipal institutions, pure and simple, were amongst the fundamental systems of Government laid down by Menu, the earliest of Hindu lawgivers.

The following description of a Hindu township in early ages, its privileges and administration, is given by Elphinstone in his *History of India (Hindu Period)* :—

“ A township is a compact piece of land, varying in extent, inhabited by a single community. The boundaries are accurately defined and jealously guarded. The lands are divided into portions (analogous to the *holdings* of the present time), the boundaries of which are as carefully marked as those of the township : and the names, qualities, extent, and proprietors of which are minutely entered in the records of the community” (*i. e., the assessment registers*). “ Each township conducts its own internal affairs. It levies on its members the revenue due to the State, and is collectively responsible for the full amount” (*a fact which Sir John Strachey, no doubt, had in remembrance when he provided for the levy of the Imperial License Tax of 1878, through the agency of the Municipalities*). “ It manages its own police, and is answerable for any property plundered within its limits. It administers justice to its own members as far as punishing small offences and deciding disputes in the first instance. It taxes itself to provide funds for its internal expenses, such as the repairs of the walls and the temple, and the cost of public sacrifices and charities, as well as of some ceremonies and amusements on festivals. It is provided with the requisite officers for conducting these duties and with various others adapted to the wants of the inhabitants, and though entirely subject to the general government, is in many respects an organised commonwealth complete within itself. This independence and its concomitant privileges, though often violated by the government, are

never denied; they afford some little protection against a tyrannical ruler, and maintain order within their own limits, even when the general government has been dissolved."

Now in the above we have the unmistakable essence of municipal institutions,—of the body corporate, self-elected, self-taxing, self-governing,—the *Municipium*, or free town, governed by its own laws, but possessing equal rights of citizenship with the rest of the State.

In the above we find a proof of the truth of the remarks made by Sir George Campbell, when Lieutenant-Governor of Bengal and President of the local Legislative Council: "I am myself convinced," said he, "that, in spite of difficulties and objections, municipal self-government is not foreign to this country, but inherent to it, being the ancient rule and habit of the Hindu race." But times change and old institutions become extinct, and before the advent and passage of successive waves of conquest, the ancient Hindu forms of civil government disappeared, and the municipal body corporate was a thing unknown in our day until revived on western models by that liberal-minded administrator, the late Sir Cecil Beadon, during his lieutenant-governorship of Bengal.

It is not the purpose of these pages to trace minutely the causes which have contributed to render the municipalities in the mofussil at the present day something very different to what their name implies; but that such is the case is patent to every one acquainted with their present constitution. How far the undoubtedly repressive legislation of recent years, and its interpretation by 'the powers that be,' are responsible for this state

of things, I am not prepared to say ; but there are other causes which must be remedied before these restrictions can safely be relaxed.

Those who desire to see a liberal measure of self-government granted to the citizens of our Bengal townships, will consider it perhaps unfortunate that Sir George Campbell's Municipal Bill for Bengal was vetoed by the then Viceroy, Lord Northbrook, being as it was a bill which had for its object "the enlargement of the powers of municipal commissioners, to lay less municipal work and responsibility on the shoulders of Magistrates, to make municipal commissioners elective, and in other ways to make more scope for municipal self-government." This was a measure framed by a truly liberal statesman, whose object, to use his own words, was "not an increase of taxation, but the introduction of a system of self-government." "I hold," said he, "very earnest views on the subject of local self-government. I believe that the position of foreigners like ourselves in India is a somewhat false one. I believe it is our duty to educate the people, so far as is in our power, to govern themselves. I believe that the power and the habit of self-government must come from below upwards, that it must come from municipal institutions first going upwards to higher and larger institutions." "If municipal commissioners are to have no power but to consult and advise, you cannot expect the people will take a real interest in representative institutions." "If you are gradually to bring the people to appreciate the system of self-government, to lead them to take an interest in their own affairs, they must have real and practical power in their own affairs;" and in a com-

munication to the writer in 1880, Sir George repeats : "I have always been very anxious to promote self-governing institutions *beginning from below and working upwards.*" But, unfortunately for the carrying out of these views, Sir George Campbell was, as he himself said, "a stranger and a sojourner in the land," and his utterances are now pronounced in the same legislative chamber to be the "views of a somewhat doctrinaire Lieutenant-Governor in the first flush of provincial independence, 'political cant,' 'shibboleths' of so-called progress, which may prove to be mischievous when they cease to be only meaningless." It is there declared that, "whatever may be the future of this country, it is absurd to pretend that as yet any such theories hold good ; that Bengal is an advanced province in many ways, but it is not after all quite on the same platform as Great Britain yet," and that "the people must learn to walk before they can be allowed to run." It must be confessed that these arguments are somewhat on a par with the action of the faded maternal beauty who clings to her youth and keeps her grown up daughters in short frocks, for fear people should guess how old *they* are and draw conclusions ; but still I fear we must admit that they have reason, as things are at the present. Before any change can be hoped for in the present regime, before the Government can safely loose the reins of control, a radical change must come over the spirit of the dream. Purely ornamental commissioners, whose line of business goes not beyond saying "ditto to Mr. Burke," as well as noisy agitators, meddlesome self-seeking intriguers, and flatulent orators, must give way to honest, intelligent business-men, who will meet to work, to

guide, and to improve, and not simply to practise speechifying and roll out "resistless streams of oratory,"

"With art scholastic, and theatric grace,
Unmeaning gesture, passion out of place.
Mouthing, false emphasis, and labored leer,
With all superfluous, and in nought sincere."

or from a pure spirit of obstructiveness oppose and hamper the executive in carrying out schemes of improvement, the utility of which they will not take the trouble to endeavour to comprehend. It is true that such spirits are in a minority; but a little leaven leaveneth the whole lump, and it is in the power of a very small number of the members of a body corporate to obstruct business and weary out the patience of the working majority. There are many good men and true in the ranks of the Municipal Commission throughout Bengal, and there would be many more but for the undoubted fact that business-men are deterred from giving their time, their talents, and their experience to the service of local municipalities, partly from the notorious waste of time and temper involved in sitting out the interminable harangues inflicted on their colleagues by men who delight in long-windedness and the sound of their own voices, who are proud of reading their speeches in the daily papers, and who, while they will split hairs and detain a meeting for hours on some petty personal question, will pass over the expenditure of lacs, or the settlement of some question of vital importance to the health or comfort of their fellow citizens, either from ignorance of the question at issue or real indifference to the true interests of the town; and partly from the knowledge that the commissioners as a body corporate have

no real substance, but are simply a medium through which to register the decrees of government. But that any change for the better would be effected by a system of election *is a fallacy*, and it is a fallacy which no body honestly believes in. The *people* do not seek it, nor desire it. They are in fact *utterly* indifferent on the subject, and the sensational stump oratory of a few self-seeking, self-nominated, would-be representatives of the rate-payers, no more represents the real and true aspirations of the mass of the people of Bengal or of any town in the province, or of the intelligent and respectable portion of the populace, than the three tailors of Tooley Street did those of ‘the people of England.’ The spurious popular agitations that from time to time become a local nine days’ wonder, are like the working of beer in a brewer’s vat,—the froth and scum all work to the top, while the only part that is of any worth lies hidden for the time beneath the evanescent bubbles, but it is only the ignorant and inexperienced who consider that the goodness and strength of the liquor lies in the froth; the knowing ones blow it off the surface before quaffing the amber liquid; and so with the bulk of the sham representatives who pose as exponents of the popular feeling at people’s rights and rate-payers’ association meetings. As old Congreve says truly—

“Dull rogues affect the politician’s part
And learn to nod and smile and shrug with art:
Who nothing has to lose, the war bewails,
And he who nothing pays, at taxes rails.”

Such men are no more to be regarded as representatives of the popular voice than Dr. Kinealy and his rabble followers were as those of the English people, or the ‘Police

News' and other 'Penny dreadfuls' are to be considered as fairly representing the British Press; and amongst no class are their pretensions treated with greater scorn and contempt than by the really sound and thinking portion of their own countrymen, who see through their motives, and understand the worthlessness of their pretensions.

Yet *these* are the men who would be elected were the Government weakly to give way to the clamour raised and fomented by themselves and the small and insignificant section of the Press with which they are connected, or are able to influence; and this not because they are the fittest men, or that they would be the chosen of the people, but simply because none but themselves would care to canvas an apathetic constituency, who, caring nothing about the matter, would give their votes to the first man who asked for them, and without comprehending what they were asked for, or what they were giving. The consequences would be such as neither the Government, nor the intelligent portion of the inhabitants, could contemplate with satisfaction, for instead of the management of municipal affairs being in the hands of men of standing, position, and respectability, men to whom the people of the towns would look up to with respect, it would fall into those of designing intriguers, office clerks, idlers, and the third-rate legal practitioners of the local courts. This would be a consummation certainly not to be desired.

But, in spite of all the drawbacks, I think few can doubt that there is a better future in store for our Bengal municipalities. Apart from any system of election, and despite the cavillings of disappointed would-be administrators of local affairs, let the Government, aided

by its local authorities, continue to choose the best men available for the office of municipal commissioners ; and having done so, entrust them with the fullest powers within the laws in force for the time being, refrain from undue interference or official pressure, and if the selection has been judicious, there is little fear but that the local interests will be fairly consulted, the views of the Government deferred to, in all necessary matters of sanitation and improvement, the business of the several municipalities carried on in a proper and straightforward manner, and the Government and the people alike satisfied.

CHAPTER II.

“ Pecuniæ obediunt omnia.”

As in all other undertakings, the first necessity for municipal improvement is that most important of the sinews of war—*Money*. When the municipal treasury is full, it is easy to project and carry out sanitary improvements and works of public utility, but, as a rule, Bengal municipalities are sadly crippled for want of funds, and those who have the care and responsibility of their affairs are expected to do a great deal with very limited means.

The first duty, therefore, of the executive head of any municipality is to secure a proper assessment and regular collection of the income of the corporation. The municipal fund in Bengal is usually derived from the following sources :

First—Direct taxation in some one or more of the following forms, *viz.* :—

(a) A tax upon persons occupying holdings within the Municipality according to their circumstances and property.

(b) A rate on the annual value of all holdings situated within the Municipality, known as a house-rate.

(c) A tax on carriages, horses, and other beasts of burden or draught, known as the wheel-tax, or horse or carriage-tax.

(d) Registration-fees on carts.

(e) A cess on occupied holdings for scavengering purposes, or house-service cess.

(f) Tolls on ferries, bridges, and metalled roads.

Secondly—Miscellaneous revenue, such as—

(a) Fines for offences under the various Municipal Acts and bye-laws, and the conservancy clauses of Police Acts.

(b) Warrant and peon's fees.

(c) License fees on slaughterhouses, cattle and sheep pens, and piggeries.

(d) Fees for the removal of trade refuse.

(e) Sale of hides and carcasses of animals dying within the town.

(f) Payments for town refuse for filling up tanks and low grounds, and for the services of the conservancy establishment in cleansing tanks and filling lands, being private property.

(g) Fees and penalties from the cattle pounds.

(h) Miscellaneous rents and royalties.

As a rule, the backbone of the municipal fund is the house-rate, and in order that it may yield the fullest possible amount of revenue, while at the same time its incidence shall be fairly and equitably distributed, so as not to press unduly on any class of the rate-payers, the assessment must be carefully and equably conducted; and to this end it is essential that every Municipality, large or small, should have an *assessor*, a distinct and responsible officer answerable for the entire assessment

of the town. Assessment by a local committee is a most undesirable procedure; and where a large Municipality is divided into wards, each having its own local committee, local assessments by these committees are to be carefully avoided. No real economy is to be effected by an assessment of the rates by an unpaid and irresponsible agency, and there are, as a rule, too many local influences brought to bear on members of such committees to secure equitable and impartial assessments. The paid and responsible officer, whose assessments are subject to the revision of the head of the Corporation, as well as of the Court of appeal provided for by the law (*vide* sec. 108, Act V of 1876, B.C.), is always to be preferred.

The assessment being satisfactorily completed, the next question for consideration is the collection. The agency employed for this purpose may be either contract or salaried, and after experience of both modes, I am decidedly in favor of the former. Where the collector receives a fixed rate of commission payable only on the amount of the bills actually realised by him, it becomes, as a matter of course, his chief aim and object to realise as many rates as possible, and to return to the warrant officer as few unrealised bills as may be. With a salaried agency, on the other hand, there is no incentive to take trouble to collect the rates; and it requires but little acquaintance with native agency of this kind to know that *trouble* is the very last thing a native of this country will take upon himself so long as he can shuffle through his daily task without endangering his salary. It is quite another thing when money is to be made by exerting themselves, and the *takka*, or rupee,

is quite as potent a stimulant in this country as the *almighty dollar* is amongst our American cousins. But whichever class of agency be employed, sufficient inducement must be offered if you expect a satisfactory return, and it will be found that, in remunerating municipal servants, as in every other branch of the public service, judicious liberality is in the end the truest economy.

No sanitary arrangements will work satisfactorily in this country unless there is constant and careful supervision in every department; and this can hardly be secured without European or Eurasian agency in the supervisors', inspectors', and overseers' grades.

Natives of this country are far too heedless and apathetic in matters of the kind. Caste and social prejudices will hardly permit really respectable Bengalees to accept employment in a department where they are necessarily brought into immediate personal contact with mehters, haris, nightsoil carts, and the like; or if they do enter the service, their duties are almost sure to be unsatisfactorily performed, and they will shirk giving that close personal attention which alone can secure efficiency. After a long experience in municipal administration, during which I have had to work almost entirely with native subordinates, and while gladly admitting that they possess many admirable qualifications for work in many departments, such as assessing, collecting, ministerial and other office work, as well as in the roads and works department, I am convinced that they are constitutionally and morally unfitted for the duties of sanitary and conservancy officers. As a rule they are effeminate, timid, and of indolent temperaments, unbusiness-

like and perfunctory to a degree; they seldom take any real interest in their work, but too often look upon it as an irksome task, to be shuffled over with as little discomfort to themselves and as distant a contact with its *disagremens* as possible. They are *unobservant*! having eyes, they see not; having ears, they hear not; neither will they understand; they are utterly wanting in emulation or any feeling of pride in their work; they will muffle their noses in their *chudders*, and pass by a foul odour a dozen times in the week without troubling themselves to investigate the cause. They will allow holes and gaps to work up the road surface, or railings and fences to go to ruin before their eyes, without taking the initiative to hinder destruction by timely repairs. They will work cattle with sore backs and unshod feet till they go dead lame, and rickety carts till they drop to pieces; and they are wilfully and negligently blind to the shortcomings and neglect of their subordinates, and culpably silent as to their misdeeds. In fact, they hate and despise their duties whilst accepting the honorarium attached to them, and they are too often wanting in the moral courage necessary to enable them to do their duty in a straightforward, fearless, and impartial manner.

I fear this will be considered too sweeping a condemnation of the class from which these men are recruited, but it is not intended to be so; I speak only with reference to their fitness for a particular class of duties, and that not of the most pleasant or desirable character.

A conservancy officer will never be a popular character if he does his duty throughly. It is impossible that

he should be, nor is it necessary. He should be always among the people, but *not of them*. A good overseer must be a man with tact and good temper, mild but firm, not to be turned aside from his duty by promises, threats, or abuse; but not given to retorts, vituperation, harsh language, or threats of reprisals.

He should be active, methodical, and observant, taking note of every little defect, and remedying it at once. Thoroughly imbued with the truth of the maxim that "a stitch in time saves nine," he should never get into the habit of overlooking trifles, for it is, as a rule, the aggregation of trifling nuisances that go to make a neighbourhood untidy and uncomfortable. He should take a real interest in his work, and a pride in keeping *his* ward, if possible, cleaner and tidier than the others.

He must *do things*, and not be always *going to do them*. He should never put off till to-morrow what can be done to-day; procrastination is one of the curses of this country. If you order anything to be done by almost any class of workman, however trifling it may be, the invariable answer is "*atcha, kal korebo*" (very well, I will do it to-morrow). He should possess the faculty of organization, otherwise his available labor will be frittered away without any useful result, and he should have sufficient firmness of character to control his subordinates, take from them their full share of work, and insist upon their obedience to orders and rules, and bring them to punishment if they misconduct themselves. That he should be thoroughly upright and honest, '*cela va sans dire*.'

An overseer who fulfils all the above conditions would be as valuable as he is rare.

The objections to the employment of Europeans as overseers are, that the salaries allotted for this class of work are seldom sufficient to secure good men; and a *badly paid* overseer cannot be expected to render either efficient or honest service. Really respectable men will hardly accept such service unless under the pressure of actual want and to keep the wolf from the door for the time being, and the only class from which European overseers may be obtained at the rate of salaries usually considered sufficient,—*viz.*, pensioned or time-expired soldiers,—seldom acquire the language sufficiently well, or understand the people, or they them, and they are thus apt, ignorantly and unintentionally it may be, to offend the prejudices or wound the feelings of the native population. That this is the case is not to be wondered at when we consider the only experience they have had of native life and character. This has, as a rule, been restricted to the bazaars in the cantonment, and the purlieus of the barrack, where they have been brought into contact with only the very lowest, most disreputable, and most abandoned specimens of the natives of the country, male or female. They thus imbibe erroneous views of native life and character and prejudices, which are sure to bear unpleasant fruit in after years when a transfer to civil employment in the country brings them into wider and closer connexion with the people. The dislike is mutual, the Bengalee naturally resents the domiciliary visits of the European or Eurasian overseer much more than he does those of his own countryman, especially if he be one of the superior castes; and when to the fact of the intrusion on his

privacy is possibly added harsh language, or what he may consider insult, arising most likely from imperfect knowledge of the vernacular, his indignation is aroused, and complaints are preferred to the higher authorities.

Europeans of this class are also too often given to intemperate habits, and this, combined with insufficient pay, lays them open to manifold temptations, which their native subordinates are too ready to take advantage of to their own profit, and the ultimate ruin of the unfortunate tools of their rascality.

On the whole, therefore, we must depend on Eurasians and on natives of the country principally as overseers, and we can only hope that, by careful selection and good training, we shall, in time, secure a better class of men than we have at present. It is true that the country now swarms with the alumni of our local colleges; the outcome of that system of State education which bids fair to leave Bengal without tillers of the soil, artizans, and traders, while swamping the professions, the public offices, and every department and business, where a knowledge of the three R's is a necessary qualification, with B.A.'s or B.L.'s, or holders of some degree or another. Indeed, so impressed is the native mind with the open-sesame powers of a little learning, that, a by-no-means-uncommon *qualification* of many who now apply for clerkships and other appointments, is, "that they have studied at the so-and-so institution, and *failed to pass* the Entrance Examination." "If they are not the rose, they have been *near the rose*."

CHAPTER III.

“Naturam expellas furca, tamen usque recurret.”—*Horace.*

(Though you should expel or restrain nature by force, she will still resume her sway.)

It is an incontrovertible fact, that “the more man follows nature and is obedient to her laws, the longer are his chances of life; and the further he departs from following them, the shorter and more troublous will be his existence.” Equally true is it, that the bulk of the insanitary evils with which we are afflicted arise from neglect of, or departure from, those laws of nature “which govern and support the mighty frame of universal being.”

No doubt, of late years, there has been a great awakening of sanitary science as applied to the surroundings of our everyday life, but that this is so must be ascribed to the increasing artificiality of our modern ways and habits, which, departing more and more from the simple paths of nature, carry with them or create an attending train of evils, and, as a consequence, necessitate their remedy by artificial means.

The unwritten laws of sanitation are as old as the beginning of the world, but the first written precepts on the subject are those of Moses, the great Hebrew law-giver, which he delivered to the Israelites when they came up out of the land of Egypt.

In fact the keynote of all our modern systems of conservancy of towns and encampments is to be found in the 23rd chapter of the Book of Deuteronomy.

Ancient, however, as sanitary laws may be, they do not seem to have been in vogue at any time among the Hindus; and this, although the Hindu shastras teem with laws for the purification of the body and household cleansing. Mill says that, in spite "of the frequency and care with which Hindus perform religious ablutions, few nations are surpassed by them in the total want of physical purity in their houses, streets, and persons." In support of his views he quotes Mr. Forster, "whose long residence in India and knowledge of the country render him an excellent witness," and who, speaking of the narrow streets of the sacred city of Benares, says: "In addition to the pernicious effects which must proceed from a confined atmosphere, there is, in the hot season, an intolerable stench arising from the many pieces of stagnant water dispersed in different quarters of the town. The filth also which is indiscriminately thrown into the streets and there left exposed (for the Hindus possess but a small portion of *general* cleanliness) adds to the compound of evil smells." The author whose duties at one time required him to patrol the streets of Benares from ten at night till gunfire in the morning, can confirm what is said above of the streets of that city, although it is probable that municipal improvement has now somewhat remedied the old state of things. In 1864, the Hon'ble John Strachey, then President of the Sanitary Commission for Bengal, wrote of the northern or native part of Calcutta, which contains some hundred thousand people, that it was "no

figure of speech but the simple truth to say, that no language can adequately describe its abominations. In the filthiest quarters of the filthiest towns that I have ever seen, either in other parts of India or in other countries, I have never seen anything which can be for a moment compared with the filthiness of Calcutta."

The authors of the *Universal History*, also quoted by Mill, describe with pure and picturesque simplicity a custom of the Hindus, which must be pretty familiar to an old Indian resident:—"The women scruple no more than the men to do their occasions in the public streets and highways, for which purpose they go out in droves to some dead wall in the city, so that it is ill taking the air either in the streets or without the towns near the river and ditches." And an old medical writer on the endemic fever of Bengal says: "The banks of the sacred Ganges, which supplies alike drink for the living and a final receptacle for the dead, presents, particularly about the rising and the setting of the sun, a motley group of all classes, and sometimes both sexes, sacrificing to the Goddess Cloacina, in colloquial association; and in some places, where eddies prevail, a whole vortex of putrid corpses may be seen circling about for hours together, and from one hundred to one hundred and fifty of these disgusting objects may be counted passing any one point in the course of a day."

The late Dr. Cutcliffe, whilst Civil Surgeon of Dacca, wrote of the condition of that ancient city:

"It must be admitted, I conceive, that, in Dacca, *for ages past*, the excreta from the entire population has been allowed to remain in and about the houses and

the compounds of the people ; that no conservancy system has ever existed ; that the water in the wells is horribly polluted, no means being taken to prevent the filth and excreta from finding their way into the wells, and that the river-water is fouled by excreta and dirt cast along the banks of the river.

“In short, that no one can deny that the air which the people breathe is dangerously impure ; that the soil on which they reside, besides being porous, damp, and undrained, is made up very greatly of the decomposing excreta of the present, and the more or less decomposed remains of the past, generation.”

Dr. Kanai Lal Dey, Rai Bahadur, in a paper on Hindu social laws and habits, viewed in relation to health, says : “The Hindu practice of household cleanliness is rather a strange compound of anomalies, for while they will have their rooms cleaned by sweeping, by scraping, and by sprinkling of water for more than once a day, they will suffer the sweepings and the scrapings, and the refuse of the house, to accumulate and to putrify under their noses, contaminating the very air they breathe.”—(*Journal of British Medical Association*, March 1860.)

In fact, Hindu ideas of cleanliness go little further than the personal cleanliness inculcated by their religion. The washings, sweepings, and plastering with clay and cowdung are all more or less ceremonial observances bound up with the religious system which proclaims the indefileability of the sacred stream, and which declares that, “pure or impure, clean or muddy, stinking or odoriferous, its water may be drunk with everlasting benefit to the human soul ; and that a man should not

scruple if he found any filth mixed with his drinking water, when that water was drawn from the Bhagirutty, but separate the filth from the water, and drink the latter with a light and gladsome heart.”—(Dr. K. L. Dey’s address.)

We must not, however, overlook the fact that the Hindus are most conservative in their adherence to their old systems of ceremonial cleansings, and that these were inculcated in the earliest ages, when men led much more primitive and natural lives than they do now, when their habitations were scattered amidst groves and gardens and fields, and not crowded into close, confined, and therefore, necessarily, filthy streets and gullies. There was then not the same necessity for close attention to the removal from the vicinity of human dwellings of excretal matters and filth of all kinds. Men living in thinly populated countries, following an agricultural or nomade life, would not suffer from these causes. The sewage matters would be desiccated by the sun, deodorised by the soil, and, in return, fertilising the latter, be a benefit to man, and not a danger. “It is only when men collect in communities that the disposal of excreta becomes a matter literally of life and death” (Dr. Parkes); and thus the laws of cleanliness and purification laid down by the early Hindu lawgiver had reference to the person and the private dwelling only, and not to public hygiene as applicable to the congregation of men in towns, cities, or camps.

The foundation of sanitary law is that which is common to all law whatsoever,—*viz.*, expediency, the necessity of things. Necessity requires that certain restraints should be imposed on all classes of the community, from

the wealthy landowner to the meanest peasant, and that individuals should occasionally be called upon to make certain sacrifices for the good of all. But when it is considered to what end these sacrifices are made, no less a matter, in fact, than the safety, health, peace, comfort, welfare, and life of the whole community; that those called upon to make them receive a *quid pro quo* in personal immunity from disease, danger, and discomfort to the same extent as their fellow citizens; that they are, indeed, no greater than others of their neighbours have to submit to;—and when it is taken into consideration that the trifling restraints and the comparatively small pecuniary contributions levied from them are, where the public hygiene and the local administration are wisely directed, amply compensated by the increased safety, health, and comfortable enjoyment of life,—there is surely no man possessed of a liberal and rational mind who will complain of the levy of reasonable taxation or the enforcement of reasonable and proper regulations. The broad principles upon which sanitary laws and regulations rest are these: that every individual member of the community is entitled to protection in regard to his health and comfort, as much as he is in regard to the security of his life and property; and that, while property has its rights and privileges, it has also its duties and responsibilities, and that no man is entitled so to use, or keep his property in such a manner, or in such a condition, as to make it a cause of offence or annoyance to his neighbours; and thus it is that, when men collect together in communities, that individual interests become, to a certain extent, merged in, or subordinated to, the interests of the community at large.

In the earlier ages, when all knowledge and science, sanitary or other, was, as a rule, confined to the priestly classes, the aid of religion and superstition was invoked to compel observance to those natural laws which it was necessary to adhere to if the health of communities was to be preserved and plagues averted. But in the present day it is necessary to base our sanitary regulations upon a more utilitarian foundation,—*viz.*, that the individual must be content to sacrifice a small part of the possible profit or pleasure he might derive from the unrestricted use of his own estate for the general benefit or enjoyment of the community.

The sanitary law will not interfere with the exercise of every man's undoubted right to carry on his trade or business, or to utilise his property in any manner in which it may be profitable or pleasurable to himself, merely because it may be objectionable to an immediate neighbour.

To bring such an use within the purview of the law, the *public* must be inconvenienced, and whatever conduces to hinder or affect the enjoyment of life or health by the public at large, must, in the general interest, be restrained. Sanitary science, with its practical applications, being thus admittedly indispensable to the welfare of populous communities, justly demands the attention bestowed upon it, not only by the medical profession, but by all who are interested in the health and comfort of our towns, and the physical welfare of their inhabitants; and its admitted expediency amply justifies the efforts made (and where rendered necessary by ignorant or factious opposition, the pressure applied) by the Government of this country to induce greater attention to its observ-

ances and dictates on the part of municipal committees and other local authorities. We constantly find in this country that attempts to improve the sanitary condition of our towns, even in the very metropolis of India, are strenuously opposed, on the ground that such improvements involve interference with the private rights of property, and possible pecuniary injury to individuals; and there have not been wanting well-known writers on political economy, notably John Stuart Mill, who are opposed to State interference in such matters, on the plea that such interference may possibly do more harm than good. It must, however, be admitted that the State must protect those who are unable to help themselves, or who are incapable of discriminating between what is and what is not necessary for their own good;—and this is undeniably the condition of the mass of our Indian town populations. In regard to questions of sanitation and hygiene, they are as ignorant and helpless as children or imbeciles, and it is, therefore, the undoubted duty of the State, and under it the local authorities, to do for them what they cannot do for themselves, and what selfish and short-sighted landlords will not do for them; and considering that the cost of general sanitary improvement must be met by taxation, a remark recently made in the Bengal Legislative Council was pertinent and felicitous: “In India,” said Mr. Mackenzie, “a foreign, but we hope a benevolent, Government, taxes the people in their own interest, and often in their own despite.”

Large towns are the foci of diseases of all descriptions. It is in them that the various causes of bodily suffering and discomfort attain their height, operate most powerfully, and produce the most serious consequences; and it

is, therefore, to them that the sanitary reformer must principally direct his attention, and it is in the quarters inhabited by the poor and labouring classes that insanitary conditions are most plentiful, and the soil and the atmosphere alike attain the lowest depths of contamination. Such are the bustees and kintals of Calcutta, the gowalparas and bustees of the suburbs, the Sankribazar and chamarparas of Dacca, and the back-slums of Patna and Benares.

To lavish money on costly schemes of watersupply, urgent as the necessity for purer water may be, on fine roads, gas-lamps, commemoration halls and institutes, or on zoological gardens and parks, is but a mockery whilst the drainage of the subsoil and surface water is neglected, the soil and the foundations of the dwellings saturated with filth, accumulations of excretal matter and organic filth abound, and the air is laden with noisome emanations. No human being can have health or enjoyment, no child can flourish and grow up to active youth and vigorous manhood, in a tainted atmosphere, and no atmosphere can be otherwise than tainted and poisonous where such conditions exist as they do in full force in most of the poorer quarters of our Indian towns.

And is it a matter of surprise that, in such towns under such conditions, cholera is an endemic and prevailing disease; that dysentery, diarrhœa, and enteric fevers are ever present; that the rates of mortality are alarmingly high, and that sickness and semi-starvation stalk hand in hand amongst the dwellings of the poor?

CHAPTER IV.

“ All the infections that the sun sucks up
From bogs, fens, flats ”

“ As wicked dew as e’er my mother brushed,
With raven’s feather from unwholesome fen.”

Shakspeare.

Malaria is a word in common use in the mouths of persons of all classes, the learned and the ignorant alike. Populations are said to be ‘*suffering from malaria* :’ various conditions of soil and atmosphere are described as ‘*pregnant with malaria* ;’ certain localities are called ‘*hotbeds of malaria* ;’—and yet comparatively few of those who use the word have a very clear conception of its meaning. Many use it because they have heard others use it, or because it is a fine sonorous mouth-filling term for some insanitary state of things which they do not otherwise know how to describe, and which has, in their mind’s eye, assumed a special form, compounded of dank jungle, foul water, thick fog, reeking mists, fevers, rheumatisms, *et hoc genus omne*.

What is Malaria? Webster describes it as follows : “ Malaria, Italian *mala aria*. Latin *malus*, bad, and *aria*, air. Bad air ; air tainted by deleterious emanations from animal or vegetable matter ; especially noxious emanations from marshy districts, capable of causing

fever or other disease ; miasma." (" Miasma, G. *μίασμα*, defilement ; infection floating in the air, the effluvia or fine particles of any putrefying bodies rising and floating in the atmosphere, and considered to be noxious to health ; deadly exhalations.")

Dr. Jackson, Sanitary Commissioner of Bengal, 1873, says:—"Of the intimate nature of malaria nothing is known. Chemistry has failed to detect it in marsh air, nor has the microscope been more successful. Those who believe in such an entity, are constrained to infer its existence to the present time. It has never been seen. Formerly it was supposed to be of gaseous nature. More recently the opinion that it consists of minute organisms, such as cryptogamic sporules or infusorial ova, has gained supporters. By some its existence is denied altogether, the phenomena attributed to it being accounted for by alternations of temperature and chill. Its existence is inferred wherever fevers of a distinctly paroxysmal or intermitting character prevail. Its alleged characteristics are:—

"That it exhibits a preference for moist and low-lying situations ;

"That it is most pernicious at night, whether from concentration, or the colder atmosphere, or because more copiously evolved from the soil, is not known ;

"That it is heavier than air, and collects near the ground or in the lower regions of the atmosphere ;

"That it is capable of being carried by currents of air to localities distant from where it is produced ;

"That it is destroyed or absorbed on passing over water ;

"That thus dissolved, or contained in water, it is introduceable into the system when such water is drunk ;

“That it is attracted by, and retained in proximity to, trees and foliage ;

“That it requires a temperature between 50° and 60° Faht. as a minimum for its development ;

“That it is most abundant and virulent the nearer the equator or seacoast ;

“That it disappears under cultivation ;

“That it is dissipated and destroyed by fire.”

Without troubling ourselves further as to its exact nature or composition, we may take it as a generic term for a certain insanitary condition of the atmosphere, arising from excessive humidity of soil charged with organic matter in a state of decomposition, prevailing in low-lying and badly drained districts, and especially in the air of marshes and fen lands ; and in this interpretation it may be taken wherever it occurs in the following pages. As to its component constituents, Dr. Wilson says :—“The air of marshes generally contains an excess of carbonic acid, light carburetted hydrogen, watery vapour, sulphuretted hydrogen, and organic effluvia ; it also abounds with the debris of vegetable matter, infusoriæ, and insects.”

As we shall have to allude to these gases in the course of these pages, it may be well to note here their composition and natural history.

Carbonic acid is a heavy colorless gas without smell ; when mixed with air, a deadly poison, instantly extinguishing a flame, and suffocating in a moment any animal plunged into it, as is exemplified in the case of the well-known *Grotto del Cane*, near Naples, in Italy, into which dogs are thrust for a few seconds and withdrawn in a state of insensibility from the

effects of the carbonic acid gas, which issues from fissures in the ground. It is produced by combustion, fermentation, and the decay of animal and vegetable matter; and is abundantly thrown off by the lungs in the act of respiration,—the carbon of the blood combining with the oxygen of the air forming this noxious gas. A recent example of the production of this gas, and its deadly effects, occurred in Calcutta, in August, 1880. The *B. S. Cape Verde*, laden with grain, was damaged, and had to be beached. Coolies were engaged to discharge the damaged cargo, when two of their number fell into the hold, suffocated by the gas generated by the rotting grain. An African stevedore attempted to rescue them, but fell down insensible the moment he entered the hatchway, and was with difficulty drawn back. A number of globe lanterns, lowered into the hold, were at once extinguished, and an attempt to enter it in a complete diver's dress was found unavailing.

Sulphuretted hydrogen, a gas possessing a most offensive smell, that of rotten eggs in fact, is produced by the putrefaction of bodies containing sulphur, which, set free by decomposition, unites with hydrogen. In the mineral kingdom it is found in the gas issuing from volcanoes, and in mineral waters, such as the Harrgate springs. It is the most poisonous of all known gases. "One part in 1,500 of common air will kill birds; one in 1,000, dogs; and one in 250, horses."—(Meymott Tidy's *Modern Chemistry*.)

Light carburetted hydrogen is a synonym of marsh gas, which is found in stagnant ditches, wherever vegetable matter is decomposing out of contact with air, but in the

presence of moisture. The exact chemical composition of the vapours arising from the decomposition of animal and vegetable matter, is a mystery at present unsolved.

Wherever, therefore, such a condition of the atmosphere as above described prevails, there we find the home of intermittent fever or ague and other marsh, or in other words malarious, diseases. The inhabitants of such localities suffer from fevers, diarrhoea, dysentery, enlarged and indurated spleen; and even those who have no specific disease often present an enfeebled and pallid appearance. Such a state of things has been very prevalent for years past in Lower Bengal; and in the Suburbs of Calcutta alone, a district of twenty-three square miles, with a population, according to the last census, of 257,000 persons, there were in the five years, from 1875 to 1880, 31,770 deaths from fever alone. In the Teraie and Western Dooars, fevers of this type assume the most malignant form, and we find European settlers in the newly-opened up tea districts returning with enlarged and indurated spleens, jaundice, emaciation, cedematous legs and feet, hot dry hands, and every symptom of malarial poisoning. The Sunderbuns, and the then newly-established but short-lived town and port of Canning, on the Mutlah, possessed an unenviable reputation in this respect; so much so, that the type of fever contracted there was commonly spoken of as "the dangerous Mutlah fever;" but, from an experience of three years' residence, I am myself persuaded that its unhealthiness was greatly and unjustly over-estimated.

Atmospheric or common air, or that which we breathe, is the first necessity of animal life, and its purity or

impurity is of the greatest importance in regard to the health of towns and habitations. It is composed of oxygen and nitrogen, in the proportion of about one part of the former to four of the latter; or, to speak more exactly, it contains 20·61 oxygen; 77·95 nitrogen; ·04 carbonic anhydride, commonly called carbonic acid; 1·40 aqueous vapour, with traces of nitric acid, ammonia, carburetted hydrogen; and in towns, sulphuretted hydrogen, and sulphurous anhydride or volatile spirits of sulphur.—*Miller.*

The carbonic acid and aqueous vapour vary according to circumstances and locality, the proportions of the other component parts remaining relatively the same in all places and climates and at all heights, from the sea-level to the tops of the highest mountains.

Of all elementary substances that which nature has provided most abundantly, and that which is of the greatest importance to living beings, is *oxygen*, which is a colorless, odorless, invisible gas, a little heavier than common air. Pure oxygen cannot be breathed without risk of injury or death. Dr. Meymott Tidy says,—“Compressed oxygen is the most fearful poison known, producing violent convulsions, and ultimately causing death.” Diluted, it is a necessity of life, and as a certain space can only contain a certain proportion of oxygen, and as every living creature in that space is continually inhaling and consuming it, it follows that where free circulation of air is impeded, the supply becomes exhausted and the air less fitted to support life.

Aërial impurities are of two kinds,—gaseous matters and organic matter in suspension.

Of the first, the principal and most noxious in towns

is carbonic acid gas. In close and overcrowded dwellings, the oxygen in the air is constantly being consumed, and the vacuum thereby caused is occupied by the carbonic acid thrown off by the lungs, by the combustion of fires and lights, and by the decay of organic matter constantly going on around us.

From three to four hundred cubic feet of air are passed through the lungs of an adult in twenty-four hours, the air being deprived of oxygen to the extent of about five per cent. About fifteen cubic feet of carbonic acid is expired during the like period.

Here we have the explanation why a constant supply of fresh air is required to maintain life, and why close, ill-ventilated and overcrowded dwellings are so inimical to health.

The well-known instance of the Black Hole of Calcutta will at once recur to the reader's mind. Tidy says,—"Air containing 4 or 5 per cent. of carbonic anhydride, such as air once breathed, causes a sense of oppression with headache distress, and perhaps delirium and coma. Air containing 3 per cent. cannot be breathed without great distress, and will, probably, produce insensibility. An atmosphere containing 1 or even 0.5 per cent. is distressing. Its presence in the proportion of 0.1 per cent. may be considered the boundary line between good and bad air."

Dr. Parkes says, that "when the amount of carbonic acid in an inhabited room amounts to 0.7 per 1,000 cubic feet of air, the organic matter in suspension, which forms one of the impurities of vitiated air, becomes distinctly perceptible to the sense of smell."

Carbonic acid is largely produced by the fermentation

and decay of animal and vegetable matter. This is one reason why heavy jungles and huts buried in luxuriant rank vegetation, surrounded with dank rotting leaves and undergrowth, and situated perhaps on the margin of ponds and water-holes, overhung and shaded from the desiccating rays of the tropical sun and the dissipating influence of fresh breezes by forest trees and heavy bamboo thickets, are so unhealthy.

How many habitations of the kind are there not throughout Bengal, inhabited by poverty-stricken peasants or artisans? Small, low, and deficient (both from their construction and surroundings) in light and ventilation, erected often on a damp water-logged subsoil, they are, as a rule, overcrowded, and their inmates have the common aversion of the poor and ignorant to the admission of fresh air. Closely thatched, the projecting eaves coming down to within five feet of the ground; with mud walls and floor, the interior measurement, perhaps, fifteen feet by ten; they have one door, always closed at night, and every crevice is carefully closed with matting or rags when there is sickness in the house. In this space are crowded together six or seven human beings of varying ages, from the wrinkled crone of fifty to the child in arms. Here they cook, eat, smoke, sleep, and exist. Here they often lie shivering or burning alternately with fever, writhe in the pangs of cholera, or rave in the delirium of smallpox; and here they *die*. Fancy this interior at night, the door closed to keep out the damp and malarious exhalations of the night, the inmates asleep on mats or filthy ragged quilts spread on the clay floor. Every living creature in that den is engaged in inhaling as much oxygen as the vitiated

atmosphere will yield; and exhaling carbonic acid gas, watery vapours, and noxious effete matter from their lungs and pores. And yet these are the unfavourable circumstances (aggravated by scanty innutritious food, and water which is often poisonous in its impurity), under which numbers of the poorer classes of our Indian towns and villages strive for existence.

Few "know how they live. how life in them,
Still feebly lurks from morn to ghastly eve,
From eve to haggard morn."

It must not, however, be supposed, that poverty and misery alone are the causes of the insanitary state of these habitations. The following graphic description, which appeared in the *Calcutta Review*, and has been reprinted in Hunter's Statistical Account of Bengal, is a proof to the contrary :

"The dense mass of vegetation in which all Bengalis delight to shroud themselves, and which encircles the rich landholder's palace, as well as the peasant's hut, is everywhere more or less productive. It is composed of the materials for food or for building—the cocoanut, the bamboo, the jack tree, and the mango. There may be seen the slender stalks of the betel tree and the towering stems of the cocoanut above them, their long arms waving in the breeze; on the other side, probably, a thick garden of plantains, that curious link between the vegetable and the timber; in the back ground an underwood of wild cane, twining itself round everything of firmer bulk; and a little further on, an undistinguishable mass of thorn, creepers, and underwood of every shade, length, and denomination. The husbandman must have his fruit trees and his bamboos, which yield him a return for no

expenditure of labor but that required for gathering or cutting—his protection for the womankind, and his shade against the fierce sun of April and May. If he attains these primary objects, he is content, no matter how much miasma may be exhaled from the decaying vegetation, how many diseases may lurk in that fair but deceitful mass of green foliage, how many reptiles and venomous snakes may be concealed in the unwholesome shades which surround his paternal inheritance. The sun and the gaze of the passing neighbour must alike be excluded. Grant him this, and he will endure with stoical fortitude the periodical fever, the steamy heat of the rains, and the fetid water which stagnates in the pools, whence he has dug the materials for his homestead site (bhita), and which never feels the influence of the breeze and the light.”

Dr. Julian Jackson, when Sanitary Commissioner of Bengal, reported: “It is greatly to the want of adequate protection from the cold at night, as well as against the glare of the sun by day, that the predeliction of the people for encouraging the growth of underwood and jungle round their houses is due. There is no doubt that it is a source of warmth, protecting the people at night from chill winds and currents of air; but when disease appears it obstructs the very ventilation that is needed for its dissipation. The great objection to jungle is, that it is invariably used for purposes that pollute the air, such as defæcation, deposit of refuse, &c. Bamboo jungle is absolutely necessary for repairs and constructive purposes, but, in the absence of all attempts at sanitary regulation, is invariably used as a village latrine. I know of no sanitary measure that excites the villager’s

indignation to such a pitch as the removal of jungle ; and have frequently heard them attribute the outbreak of disease among them to this cause, alleging that the exposed soil gave off noxious emanations to the sun's rays, which, considering that such sites had been the receptacle for filth of all kinds for many years before till the soil was thoroughly saturated with organic material, was probably true enough."

Another source of air pollution is the practice which obtains throughout Bengal, of digging pits from whence to take earth to raise the floors and plaster the walls of the huts. These eventually become the *anstakoor*, or the general cesspool, receiving the filth and ordure of the household, the garbage of the cookroom, and the draining of the cow-stall, and remaining more or less full of water according to the season : rank vegetation springs up in them, dies down, and rots in regular succession. They thus become foci of foul gases and malarious exhalations. Legislation has provided for the prevention of this form of nuisance ; and in spite of the obstinate opposition of even some of the most enlightened and learned natives, who regard such measures as interference with the sacred rights of private property, Municipal Committee-men are awakening to the necessity, in the interests of the people themselves, of suppressing the practice.

A fruitful source of aërial impurity is the foul vapour arising from drains, sewers, and privies, especially that most objectionable institution known as the *Sundaish*, or well-privy, which was till lately, and still is, in many places the universal accompaniment of every native dwelling of the better sort. In Calcutta and the suburbs, until within the last few years, there were one or more

in every brick-built native house throughout the Municipalities. The following description of a privy, taken from the Sanitary Commissioner's report, is not an exaggeration of what used to be the universal state of things:—

“The private privies in general use are demi-upper-roomed ones, on the upper floor of which there are two holes on which the people sit and allow the excrement to fall into the room below, where it is allowed to accumulate. Some of them are cleaned out every two or three months, others again annually. In the rainy season especially, the filth is poured down on the roads and into the drains after heavy showers of rain.” Add to this that generally there was a well or pit sunk in the floor of the lower compartment, and that the filth in that case was never removed, and we have a picture of the well-privy.

An instance which came under the writer's notice a few years ago, will illustrate the subject as well as give some idea of the apathy with which natives of this country, even men of education and enlightenment, regard the existence of such evils. A native of wealth and education, a member of the native Bar of the High Court, was the owner of a range of tenanted buildings in a principal street of the town. There were forty tenants, who used a range of privies built over a well and common to the whole premises; this *cloaca* was never cleansed, but the filth accumulated till the well was filled, *then* the lower compartment of the building; when the weight of the foul fermenting mass burst open the door and overflowed into a pond in rear of the premises. The privy and pond being in rear of the

building enclosed within high walls, the conservancy officials were ignorant of its existence till cholera breaking out in the house the cause was soon revealed. It is perhaps not so much a matter for surprize that the owner, who by the way regularly realised from his tenants the cost of cleansing, should not have seen to the cleanliness of the place; but the conduct of the tenants (many of whom were educated clerks and schoolmasters), who paid for the work but never troubled themselves to see that it was done, or complained of the neglect, is a significant proof of the carelessness displayed by natives of this country in regard to this fearful domestic danger. Talking once to a learned native gentleman, a savant with an European reputation, on this subject, he said, "I have had an uncleaned well-privy in my house for twenty years, and no harm has resulted."

Now it is a well-known fact that fecal matters, when in a state of decomposition, give forth carbonic acid, nitrogen, sulphuretted hydrogen, light carburetted hydrogen, and ammonium sulphide, besides extremely offensive odors, mainly due to organic matter,—that is to say, they produce every possible element of atmospheric impurity in their greatest intensity. But besides the mere fouling of the air, which in its vitiated state predisposes to disease, must be considered the probable diffusion of what are called filth diseases,—*viz.*, cholera, diarrhoea, enteric fever, &c.; and which it is believed may be contracted by inhaling the effluvia arising from the dejecta of persons suffering from these complaints, and even from filth in a state of putrescence, so much so that, in America, the name "nightsoil fever" has been given to typhoid fever, so directly has night-

soil improperly kept been proved to be the cause of this disease. A case reported by Dr. Carpenter proves the potency of an atmosphere charged with putrescent emanations in rendering the system liable to the attacks of zymotic diseases of various kinds. A manufactory of artificial manure existed immediately opposite Christ Church Workhouse, Spitalfields (London), which building was occupied by about four hundred children, with a few adult persons. Whenever the works were actively carried on, particularly when the wind blew in the direction of the house, there were produced numerous cases of fever of an intractable and typhoid character; a typhoid tendency was also observed in measles, smallpox, and other infantile diseases; and for some time there prevailed a most unmanageable and fatal form of aphthæ of the mouth, ending in gangrene: many deaths occurred. The proprietor of the factory was compelled to close his establishment, and the children returned to their ordinary health. Five months afterwards the works were recommenced. In a day or two subsequently, the wind blowing from the manufactory a most powerful stench pervaded the building. The night following forty-five of the boys, whose dormitories directly faced the manufactory, were again suddenly seized with diarrhœa, while the girls whose dormitories were in a more distant part, and faced in a different direction, escaped.

The manufactory having been again suppressed, there was no subsequent return of diarrhœa.

Well-privies ought to be abolished wherever found; the fecal matter contained in them should, if possible, be removed; but as this is often a difficult and dangerous operation, their contents should be disinfected by

the addition of chlorine, ferrous sulphate (green copperas), sulphate of zinc, and sulphate of iron, or what is largely used by the New York Disinfecting Corps, a mixture of dead oil and copperas (impure carbolic acid and protosulphate of iron)—(Buck. II, 413); and the well then filled up completely with dry earth, well rammed down; the mouth of the well should then be bricked over with good lime and soorkee mortar and well-burnt bricks. Whatever disinfectant is used, it must be freely employed, at least a pint of strong solution to each cubic foot of the contents of the well-privy. Fecal matters should be regularly and carefully removed from privies daily, unless the pail system, known in France and England as the *Système Goux*, be adopted, in which case removal every sixth or seventh day will be sufficient, except in cases where there is cholera or enteric fever in the house, when the excreta should be *disinfected* and removed daily. Privies and privy vaults should be regularly whitewashed with fresh lime and chloride of lime, or Macdougall's powder sprinkled on the floors, seats, and drains. After the occurrence of cases of disease, they should be further disinfected, by burning a small quantity of sulphur in the lower vault. Whether the daily cleansing or the six-day pail system be in force, constant supervision and inspection is necessary to ensure regularity and thoroughness of cleansing. Native householders cannot be depended upon to bring to notice in due time neglect on the part of the nightmen, though they are ready enough, at least the educated portion of them, to rush into print and ventilate real or imaginary grievances in the columns of the English and vernacular papers.

CHAPTER V.

“ The hollow ground ;
Being loose, unfirm with digging up of graves.”

Shakspeare.

Graveyards, especially those used by Mahomedans for the burial of their dead, are fruitful sources of the evolution of noxious gases, such as carbonic acid, phosphoretted hydrogen, ammonia, and sulphuretted hydrogen ; and are distinctly inimical to health.

Dr. Wilson says :—“ According to the evidence summed up in the Report on Extramural Sepulture in 1850, the vapours given off from thickly-crowded graveyards, if not actually productive of disease, do certainly tend to increase the sick and death-rate of the immediate neighbourhood.”

It would be idle and presumptuous for me to attempt to prove what the effects of effluvia from putrescent animal matter are on healthy subjects ; the offensiveness of smell is itself evidence of its deleteriousness. If then the evil is admitted and legislated for in Europe, where bodies are encased in coffins, and buried at a considerable depth, how much greater must be the mischief in this country, when we have bodies merely wrapped in a cloth and placed frequently barely three feet underground, and

where the earth-covering is again greatly reduced in thickness by the Mahomedan practice of placing a platform over the corpse;—and this in a country subject to the intense heat and heavy rains of the Tropics. Here there is not time for that *slow decay* of “the poor remnants of mortality,” by which the elements of organic matter are slowly oxidated or united to the oxygen of the air. On the contrary, the decay passes quickly into putrefaction, and putrid smells, with all their attendant evils, arise from the grave and vitiate the atmosphere.

And here it will not be out of place if we consider what is *putrefaction*. *Tidy* defines it to be “a spontaneous change common to all nitrogenised organic bodies when exposed to the air, whereby they are resolved into new and simpler products. The action is accompanied by the evolution of unpleasant gases, which are, for the most part, compounds of sulphur and phosphorus. It differs from *fermentation* in that *unpleasant* products are evolved, as *e. g.*, in the decomposition of a dead body. Moreover, a putrescible body is always a nitrogenised body, which, at a certain temperature, in contact with air and moisture, decomposes, and then becomes capable of acting as a ferment.

“Moreover, like fermentation, putrefaction is always accompanied by the development of certain minute living organisms, fungi, and infusoria.”

The conditions necessary to putrefaction are air, moisture, and warmth. The presence of the first is necessary only at the commencement of the process. When putrefaction has once fairly commenced, it continues independently. A perfectly dry body does not putrefy. This is exemplified by the curious dried Indian

corpses found in large earthenware jars, near Campos, in the Brazils, and by the dead monks at Malta. Warmth destroys cohesion, and thus aids putrefaction. It will thus be seen that all the elements necessary for rapid decomposition are in full force in a graveyard in this country.

The following are the opinions of some well-known Indian medical authorities on this subject :

Dr. James Anderson, late Presidency Surgeon, Calcutta, says:—" Native cemeteries situated in the midst of a populous neighbourhood, must be most objectionable not only from the carelessness with which the dead are covered up, and the frequent exposure of the corpse by the inroads of jackals ; but also from the greater virulence of effluvia arising from putrid or decayed animal matter when disseminated in a hot moist atmosphere, at all seasons more or less mixed with the emanations from decomposed vegetable matter." Dr. Anderson gives an instance, which had come under his own observation, of direct injury arising from the incautious inhaling of the foul vapours arising from a putrefying corpse : " The son of Mr. L'Estrange, the apothecary of the Presidency General Hospital, then a pupil at La Martiniere, wandered into this cemetery (Kasia Bagaun, south of Camac Street), and having approached a grave which had been invaded by jackals, was nauseated by the effluvia therefrom, and hurried home, complaining of sickness, and with a violent headache. He was attacked the same night with low typhoid fever, and though he recovered after a long and painful illness, his life was for some time despaired of." Another curious but well authenticated case is quoted by Dr. Johnson (*Influence of Tropical Climates*) :—

An American merchant ship was lying at anchor in

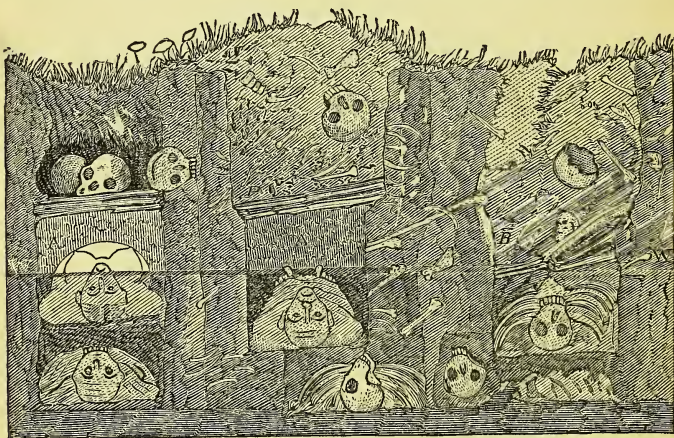
Wampoa Roads, 16 miles from Canton. One of her crew died of dysentery, and was taken on shore to be buried. No disease of any kind had occurred on board during the voyage. Four men accompanied the corpse, and two of them set to work to dig a grave. Unfortunately they hit upon a spot, where a body had been buried about two or three months previously (as was afterwards ascertained). The instant the spade went through the lid of the coffin, a most dreadful effluvium issued forth, and the two men fell down nearly lifeless. It was with difficulty that their companions could approach near enough to drag them from the spot and fill up the place with earth.

The two men affected were taken with some difficulty on board. They were attended to by the Surgeon of an English East Indiaman, but in spite of every care one died on the evening of the fourth day, the other on the fifth; both the other men suffered from similar symptoms, one of them being for three weeks unfit for duty. I need not quote at length the medical history of these cases as given by Dr. Johnson; but the disease appears to have been a very malignant typhoid fever, accompanied with suppurating buboes and other complications. The men were attended, and the *post mortem* examination conducted, by Dr. Hamilton of H. B. M. S. *Britomart*.

Dr. Norman Chevers, speaking of an old Mahomedan burial-ground in the immediate vicinity of Calcutta, says:—"It is scarcely possible that a burial place so large and so saturated with decaying animal matter can, in a tropical climate, be otherwise than offensive and dangerous to the inhabitants of its near vicinity. It is self-evident that the prevailing mode of burial in shallow graves, lightly filled in and ill-covered, must be attended

with the constant disengagement of noxious gases from its entire surface."

Dr. Goodeve says, in answer to a question put to him in connexion with a Mahomedan burial-ground:—"If by the phrase intolerable nuisance complained of by the residents in the neighbourhood of the burial-ground is meant bad smells distinctly traceable to the graves, I should consider this sufficient evidence that the products of the decomposition of the corpses were being diffused through the atmosphere, and should have no doubt that the burial-ground was a source of danger to the neighbourhood."



The above sketch will give some idea of the condition of an ordinary Mahomedan burial-ground, well known to the author. It represents a section of the ground ten feet in length by five feet in depth. A is a recent grave, P being the platform of sticks placed to keep the earth from the body, and to provide the space for the defunct Moslem to sit up in, after his burial, to answer

the interrogatories of the angels *Munkir* and *Nakeer*. B is an older grave, which has fallen in, the weight of the earth having broken the sticks, and the composition of the soil is, as shown, made up, to a large extent, of human remains of various ages; the ground being so crowded with graves that the same spot is used over and over again. W W is the level of the subsoil water in the rains. A few months ago, while inspecting this ground, the writer saw four skulls, in various stages of decay, thrown out from one grave, which was being dug to receive a new tenant then awaiting interment, while the earth presented a greasy, adipoceros appearance, and there was a most sickly offensive odour from the stuff thrown out of the grave.

We have now to consider how to remedy the evils arising from old and overcrowded burial grounds, and how to regulate interments in grounds still in use, so as to economise space and comply with sanitary requirements.

All old and unused burial grounds, and such as have from constant use become overcrowded, should be at once taken in charge by the local authority; all further interments should be strictly prohibited; and where possible, or funds will allow, the ground should be fenced in.

Bones, skulls, and other remnants of mortality should be collected from the surface and thrown into the many sunken graves that will be found throughout the ground. These graves should then be filled up, and the whole surface of the burial ground should be dug over or ploughed and levelled; all noxious weeds and undergrowth being removed or dug in; all masonry tombs, which are not entirely decayed, or which have tablets, or other

means of identification, should be carefully preserved, cleared of *peepul* or *bur* trees, and other destructive plants, and fenced in with a simple fence of bamboo or gran sticks.

In a Report on Extramural Sepulture presented to Parliament, the following statement occurs :—

“From the concurrent testimony of grave-diggers, sextons, and others employed in churchyards, it appears that decomposition goes on much more rapidly near the roots of trees than in any other parts of the burial-grounds. That the root fibres travel towards the graves and are often observed to penetrate right through the decayed wood of the coffin lids. The action of the vegetation arrests the products of decomposition, and prevents their escape into the air by absorbing them into its own substance, to be given out in another and a harmless form.”

Dr. Ford, President of the Board of Health, Philadelphia, considers that “it would be better if disused graveyards were converted into parks and planted with rapidly growing trees and herbage, to absorb the organic substances contained in the soil;” and Dr. Adams further suggests, that it would be a wise precaution to surround every cemetery with a belt of trees to act as a barrier to the escape of deleterious miasmata.

The whole area should then be planted out with plantains, guavas, sissoo, rain tree, (guango, *pithecolobium saman*), or where fodder crops are desirable, with maize, guinea grass, reana, and lucerne; but it will, probably, be found more convenient, as well as less objectionable in point of *prejudice*, to plant the ground thickly with trees, making choice of such as either fruit early, or can

be used for poles, charcoal, or firewood, within six or seven years, as after the expiry of that period the ground will again be fit for use for its original purpose.

All testimony on the subject goes to prove that a corpse laid in the earth, without the intervention of a coffin, will be resolved into the elements in five to six years, and that the ground may be re-opened without danger after the expiry of that period. Dr. Sutherland, one of the members of the London Committee on extra-mural sepulture, reported "that he found the great utility of vegetation in shortening the period of decay fully recognised abroad." There can be no doubt also that decomposition takes place much more rapidly in a hot moist climate with a wet subsoil. We have even the authority of the first grave-digger in Hamlet, that "your water is a sore decayer of your whoreson dead body;" and the same authority, in answer to Prince Hamlet's enquiry, as to "how long a man may lie i' the earth ere he rot," declared, that "he will last you some eight years or nine years, a tanner will last you nine years, his hide is so tanned with his trade, that he will keep out water a great while." My readers may smile at my taking this creation of Shakespere's imagination as an authority, but as Samuel Smiles says of the immortal bard, he was "not one, but all mankind's epitome; he gathered his wonderful stores of knowledge from a wide field of experience and observation," and there is little doubt that his grave-digger was a living character, and the opinions given, the result of actual enquiry, for of this they bear internal evidence; but to come back to more modern, and probably more reliable, authorities, Dr. Ffrench, Civil Surgeon of 24-Pergunnahs, was of

opinion that five years will suffice, though the late Dr. Goodeve has left on record that "graves should not be disturbed for at least twelve or fifteen years."

The late Dr. Parkes of Netley says:—"Bodies decay in very various times, according to soil, access of air, amount of pressure, &c. In some cases they may be destroyed in three years, but, as a rule, when ground has to be used over again, a period of from five to thirty years is allowed in different countries before reinterments. Bodies should be buried deeply (from four to six feet), in order to lessen the chance of contamination of the air, although it is supposed that when the graves are shallower decomposition is more rapid.

"The decomposition of bodies occurs by putrefaction with rapid disengagement of effluvia by a sort of insensible decomposition, the products being arrested or decomposed by the earth and by saponification. This last condition is said especially to occur if the earth is too closely pressed on the body, and gets saturated with the products of decomposition." (Public Health, by the late E. A. Parkes, M.D., revised by Aitken.)

This process of saponification results in the transmutation of the fat and muscular fibre of the body into adipocère, a soft unctuous waxy substance of light brown color, and which was first discovered, it is believed, by Fourcroy, during the removal of the Cimetière des Innocents in 1787.

Mr. Pereira, for many years undertaker, and custodian of the military burial-ground at Bhowanipore, assures me that, after the expiry of twelve months, only the larger bones remain; and from repeated enquiries and examination of the Mahomedan graveyards in the suburbs, I

am convinced that, after five years, a grave may be opened without danger ; there remaining nothing but crumbling bones, the organic matter of which, *viz.*, about 30 per cent., disappears after burial for three or four years, leaving only the inorganic constituents, *viz.* calcic phosphate, calcic fluoride, calcic carbonate, and magnesian phosphate, all compounds of calcium, behind ; and that, if the graveyard be planted as above suggested, it may be used again without danger to health or offence to decency after a lapse of five to six years. Of course, the longer time that we can let the ground lie undisturbed, the better.

The following arrangement proposed for the suburbs of Calcutta will serve to show clearly how ground may best be utilised so as to give the greatest amount of facility and economy of space with due regard to sanitary requirement :—

“The number of Mahomedan deaths in town and suburbs in 1877 was 8,600. It is necessary to provide for at least that number of burials annually.

“The number of graves to a cottah of land, allowing for each grave 6' by 2' with 4' space between each, would be twelve, or two hundred and forty to the bigah ; about 36 bigahs, or allowing for *pucca* tombs, say 40 bigahs, of land will be required annually. The lands now proposed to be taken would, therefore, last for six years, as, after three years, the intermediate four feet spaces would be used without disturbing the graves on either side. After the expiry of this period, the old burial grounds would be again fit for use, as the *cutcha* graves would be obliterated, and all trace of the bodies would have disappeared.

“These grounds would last for four or five years, which

18 months; but this would extend by so much the time the old graves would lie fallow, and the ground would be worked over in lines parallel to the eleventh year's graves."

By following out this system the ground could be used for an indefinite period.

The ground space prescribed by the Sanitary Commissioner is 6' \times 2' wide, one yard intervals; but this would not permit of the intermediate graves without disturbing the old ones.

CHAPTER VI.

“Prohibetur ne quis faciat in suo, quod nocere possit in alieno.”

(It is forbidden for any man to do that on his own property, which may injure the property of another.)

There are many trades and manufacturing processes which add considerably to the impurity of the atmosphere, and should not, therefore, be permitted in populous neighbourhoods.

The offensive and unwholesome trades,* which the Municipal law of Bengal gives local authorities power to suppress or confine to certain limits (*vide* section 285, Act V of 1876, B. C.) are :—

1. Melting tallow.
2. Boiling offal or blood.
3. Skinning or disemboweling animals.
4. Soap-houses, oil-boiling-houses, and dyeing-houses.

* By English law, a man may become responsible for a nuisance in various ways,—such as erecting and working a tallow-furnace, limekiln, tanpit, pigstye, privy, smelting-house, dye-house, Guano warehouse, noisy forge or workshop, brew-house, glass works, burning lime or bricks so near the dwelling of his neighbours that the smoke, noise, or smell renders it unfit for habitation, or by making a cesspool, the filth of which percolates through the soil and contaminates the water of his neighbour's spring, or well, &c., &c.—*Handy Book of Law and Equity*.

5. Tanneries, slaughterhouses, brick, pottery, or limekilns.

6. Any manufactory or place of business from which offensive or unwholesome smells may arise.

And under this latter head we may place the following:—

(a) Collecting and storing bones, horns, and hoofs.

(b) Dry-fish stores.

(c) Bone-crushing or phosphatic manure works.

(d) Shell-burning.

(e) Cinnabar-making.

(f) Lacdye and shell-lac works.

(g) Nitric and sulphuric acid stills and chemical works.

(h) Dry salting and hide storing.

(i) Leather-varnish boiling.

The effluvia arising from tallow-melting, offal-boiling, soap-boiling, bone-crushing, shell-burning, and lacdye-making are all very offensive, and undoubtedly constitute a nuisance within the meaning of the common law. They are caused by the fumes driven off in process of manufacture and from the decomposition of animal matter. Dr. Ballard declares that they cause headache, nausea, and diarrhœa.

Brick-burning gives forth peculiarly pungent and irritating fumes, the exact nature of which is not known, but often of a sulphurous character, due to the use of inferior coal. In England, where the brick-clay is often mixed with cinders and the siftings of dust heaps, the fumes given forth are believed to be composed principally of hydrochloric acid.

Beyond the annoyance caused, which, however, amounts

to a nuisance, there does not appear to be any evidence of injury to health from these fumes, unless breathed in a concentrated form, when they are fatal.

Shell-burning is particularly offensive, the shells often containing a large number of dead mollusca in a state of putridity. The shells are brought principally from the Sunderbunds, and are of two kinds—jhangra and jinak.

The manufacture of artificial cinnabar (bi-sulphuret, sulphuret, or sulphide of mercury or *hingool*), though not carried on to any great extent, is a most dangerous one, and should not be permitted in any populous quarter. Cinnabar is a weighty crystalline precipitate, formed by the amalgamation of sulphur and mercury, sublimed by subjection to great heat in glass retorts covered with a coating of cowdung and clay, and placed in a sandbath over a powerful furnace. The heat being maintained steadily for a period of about four days and nights, the result is a heavy crystalline substance breaking with a bright metallic fracture and of a deep red color, when pulverised. Its wholesale value is about Re. 1-4 per pound. It is largely used in the arts in the production of vermilion and other colors, and also by the natives of India as a medicinal fuming agent. During the manufacture, the mouth of the retort is kept open and the sulphurous acid gas generated, which is highly inflammable, rushes out in a jet of flame about two feet high. The sulphurous acid gas and volatilised mercurial fumes driven off in this process have a marked deleterious effect on the health of the neighbourhood, while vegetation within reach of its effects perishes, and fish and frogs die in the tanks.

The effects on human beings are a cachectic state of the constitution, diarrhœa, cough, spongy gums, loosened teeth, foul breath, and the usual symptoms of mercurial poisoning.

Chemical works are neither numerous in this country, nor do they, as a rule, injuriously affect the health of the neighbouring inhabitants to any appreciable extent.

The process of leather-japanning, which is a considerable trade wherever shoe-making, harness-making, and carriage-building is carried on, involves a most offensive process in the boiling of the varnish, which is a compound of impure linseed oil, verdigris (acetate of copper), China blue, and English black, and which, in process of boiling in large open coppers, gives forth suffocating and poisonous fumes, which pervade the atmosphere to a considerable distance, and are a source of very serious discomfort to residents of the neighbourhood.

The nuisance arising from lacdye works is caused by the large quantity of putrid animal matter, the remains of the lac-insect (*Coccus lacca*), contained in the refuse.

Bone-boiling is a most offensive trade, and is becoming a very common one in this country from the increased demand for phosphatic manures for tea and coffee cultivation. Any accumulation of bones in a raw state speedily becomes offensive, in warm weather especially, the animal oil oozes out and becomes decomposed, and butyric,* capric, and caprylic acids are formed; to these ill-smelling constituents are added the ordinary gases of decomposition. Storage of raw bones should never be permitted

* Butyric acid,—an oily, limpid fluid, having the smell of rancid butter and an acrid taste, with a sweetish after-taste, like that of ether.

amongst, or adjacent to, dwellings, the odours arising from them being a most disgusting nuisance. Bone-boiling, where the bones are perfectly fresh, is no more offensive than cooking on a large scale; but where the bones are tainted and decomposition is present, the effluvia are extremely objectionable.

Several cases of the kind, where sickness in the neighbourhood was distinctly traceable to the nauseating odours from this trade, have come under my notice, and prosecutions had to be instituted to suppress them.

Hoofs and horns, from which the 'cores' have not been removed, become putrid, breed maggots, and become extremely offensive.

The odour from superphosphate works is at times a serious annoyance, as it is of a very penetrating quality and diffuses itself over a wide extent, sometimes from one to two miles from the site of the works. Where dry bones alone are used, the nuisance, though generally complained of, is not of a very serious character.

Tanneries when under European supervision, or conducted on European models, are not generally a nuisance; nor do I find tanneries mentioned amongst the offensive trades recognised by English sanitarians. Still, on account of the odours diffused by them, and which are not always of a pleasant character, they generally are, and always should be, placed at the outskirts of a town. Small native tanneries are, however, an undoubted nuisance, which is heightened by the waste water, largely impregnated with decomposing animal matter, being allowed to run into open surface drains or on to waste lands and hollows. The tan-barks used in this country, *viz.*, babool (*Accacia farnesiana*) and

goran (*Rizophora decandra*), are much less rich in tannin than the oak (*Quercus*) and sumach (*Rhus cotina*) used in Europe, and they are thus less powerful in arresting decomposition. The subject of slaughter-houses will be dealt with in another chapter.

Although many of the trades mentioned above may possibly be carried on without causing serious annoyance to any neighbourhood, whilst thinly populated, and especially where proper precautions are taken, and the works are carried on on a large scale with modern appliances and under skilled supervision, they may become—and when conducted in the careless and primitive manner in vogue amongst natives, they are sure to become—nuisances, and it is better to exclude them altogether from populous neighbourhoods, and relegate them to out-of-the-way localities, where they can offend no one. But even here sanitary supervision should not be relaxed, but the owners should be compelled to use such ordinary precautions as are practicable and necessary to prevent nuisance, if only to preserve the health of their own workmen, who may otherwise not only suffer themselves, but communicate disease to their families, or carry it into the more populous parts of the town.

There is another source of air pollution, which, though as yet perhaps of little moment in this country, promises within a few years to add seriously to the contamination of the atmosphere of Calcutta and its extensive suburbs, as well as of Howrah, Serampore, and the towns along the banks of the Hooghly, and which it would be well that local authorities should not overlook, but endeavour to check in its infancy, and whilst its regulation will be much more easily effected than after it has in-

creased to such an extent as to involve the self-interest of a large number of the mercantile and manufacturing communities. This is what is denominated in Europe as *the smoke nuisance*, which pollutes the air by poisonous gases and by unconsumed particles of carbon, which not only blacken and discolor buildings and public monuments, but choke and destroy vegetation, and exert a very detrimental influence on animal life.

Every factory or place of business consuming a large quantity of fuel and creating smoke should be compelled to consume it.

Amongst the offensive trades, which by law are placed under the control of municipal bodies, are the keeping of horses, ponies, cows, horned cattle generally, sheep and goats.

In rural districts none of these are likely to cause any nuisance; it is only when they are kept in crowded, ill-ventilated, and badly drained localities in towns, that the emanations from them become a source of danger to health and annoyance to their neighbours. Hackney carriage, or as they are called here "ticca gharry," stables are generally kept in a most filthy and insanitary condition. They are nearly always tiled or thatched sheds, with either an imperfect planked floor, or more often the unprotected soil; the wet and urine soaks through and oozes out through the bottom of the shed to the nearest drain, or on to the unpaved yard or open space adjoining. The manure is either heaped up in the yard or thrown into a pit or low ground at the back of the stable, and there is a constant and disgusting odour of ammonia resulting from the decomposition of the urine, and the rotting of the straw and dung.

The floors and drains are the chief points to be attended to ; it matters little what the roof is made of, so long as it is water-tight and a sufficient protection from the sun ; and in a warm climate the more open and pervious to air the walls are, the better in every respect.

The floor should be made either of wood properly and firmly laid with tight caulked joints, and well saturated with Rangoon oil or coal-tar, and with a slight slope to a properly-constructed brick or artificial stone drain, jointed in either case with cement ; or the floor may be of stone, brick-on-edge cement pointed, or asphalte. The latter, when properly laid, makes an excellent flooring, and is next to wood, less tiring for the horses to stand on ; but is not lasting, and in hot weather is apt to become soft. The drain should lead to a cesspool, from which the contents may be removed by a barrel-cart. The urine and drainings should never be permitted to run into the roadside surface drains.

Where stables are situated, as is commonly the case, close to the edge of the public road, the stable-owner should be compelled to pave or macadamize the flank of the road from the edge of the drain up to the metaling for the full breadth of his stable frontage, otherwise the roadside gets trodden up into mire mixed with urine and manure and becomes a nuisance to the street. Every stable-owner should be compelled to have a proper box or basket to contain the horse-droppings, which they should empty into the conservancy carts when they make their morning rounds. Pigsties are a very serious source of nuisance and pollution of the atmosphere, especially where the animals are herded together in large numbers. So far as I am aware, pigs are not kept in

large numbers in any town in Bengal, except in the suburbs of Calcutta, where there has been for years a colony of Chinamen who carry on a considerable export trade in hogslard.

In some of these men's sties I have found from 12 to 1,500 full-grown swine grovelling in a mass of foul, foetid, sour mud, a compost of mire, dung, urine, and waste food. As the animals are fed on decomposed rice and sour swill, the combined odours were simply disgusting, and the air of whole neighbourhoods within a circle of a mile was vitiated.

The constant fighting and squealing of the animals adds to the discomfort of the neighbours, and the scorching off the bristles from the slaughtered hogs gives rise to disgusting odours.

Pigs kept in smaller numbers by Domes, Chamars, and other low castes are also a nuisance; their pens are invariably filthy, and they are generally allowed to roam about the neighbourhood, acting as scavengers, rooting up and destroying the drains and roadsides, invading the gardens of the residents, and frightening horses on the public roads.

Pigs should on no account be permitted in a town, especially in this country; they are a distinct nuisance, with no compensating advantage. All our local sanitary authorities and leading medical men have condemned them.

Sheep-pens are offensive to their immediate neighbours; the sheep being herded together, a very strong and penetrating odour arises from the animal matter contained in the fleeces. This is so well recognised in some places in France, that the water from the sheep-washes,

is carefully utilised for manure. If the yards and sheds are paved or concreted or asphalted, and the dung carefully collected and removed, there can be little objection to the existence of sheep-pens, except in very thickly populated localities or in the better quarters of a town.

Far worse than the horse and pony stables are the 'goalghurs,' or cow-byres, situated within towns, and their influence on the health of the people is manifested in so many ways that they call for something more than a passing notice.

Few people who have not seen these places can have any conception of their unutterable filthiness, and I am convinced that a visit to one of them would cure any one of a penchant for milk in any shape for the rest of their lives.

The gowalla's quarter is generally situated on the margin of a tank or pond, the water of which is constantly contaminated by the flow of urine and decomposing liquid dung, and from whence the cattle and the milk are alike watered.

"A cowhouse is generally a long shed, either thatched with straw, or golepattah, or tiled; the walls of bamboo matting, daubed with a plaster of cowdung and clay, with a clay floor raised a couple of feet from the ground level; the floor slopes inwards to a narrow drain usually formed of three planks, one forming the bottom and the other two the sides, held in position by bamboo pins driven into the earth about nine inches wide and ten or twelve inches deep; the flooring is covered with rough, loose boards, and neither it nor the drain being carefully fitted or caulked, the liquid dung and urine pass freely through the wide interstices and soak into the earth

beneath. Along each side of the shed is a raised ledge of earth in which earthen tubs or *nands* are sunk to hold the cow's fodder. The cows are tied up to posts set along this ledge with their hind feet close to the edge of the centre drain, so that they may dung directly into it. This arrangement is made to save the gowalla the trouble of clearing up the dung, but the space is so narrow that when a cow lies down she does so obliquely, and as they are closely packed together with their sides almost touching, the standing cow often dungs over the one resting. The beams and roofing are covered with a thick mass of cobwebs, black with the dust and smoke of years. There is seldom more than one door to this filthy den, and over that hangs a thick coarse curtain of gunny or such like material. A fire of dried cowdung is kept constantly smouldering inside the hut to keep away flies and mosquitoes, so that there is hardly any light, and the atmosphere is stifling from smoke, the carbonic acid gas exhaled by the cows, and the emanations from the constantly-decomposing dung and urine. The centre drain leads into a cesspool situated just outside the hut; these vary from six to twenty feet in diameter, with a depth of eight to ten feet, and are never emptied, though during the rains the contents overflow over the surrounding soil or into the nearest ditch or public drain. Sometimes under pressure from the conservancy officials, these cesspools are covered over by throwing litter and loose earth over them, forming an artificial quagmire, on the surface of which rank grasses grow, and so disguise them; and they are so numerous in a gowalla village or busti that a stranger must trust to the safe conduct of a guide to see him

safely through.”* The whole of the foundations and surrounding ground on which these cow-stables stand are so thoroughly saturated with urine and liquid dung, as to resemble more an old midden stead than wholesome earth. It will hardly be believed that such places have been tolerated for years, and still exist, not only in the suburbs of Calcutta, but even in the town itself, and that there are numbers of so-called intelligent and certainly educated people who defend their existence and strongly oppose their removal, on the ground that the gowallas have resided and carried on their trade in these quarters for many years, and that their removal to more remote quarters of the suburbs might lead to inconvenience the people in obtaining their milk-supply as well as increase the price of that necessary article.

The first evil arising from this penning up of cattle, (for it must be remembered that the milchcow never comes out of this filthy den until her milk having dried up, she goes to the butcher) is the propagation and spread of rinderpest. The mortality amongst the cows is very great. In 1872-73 I found from careful enquiries that about three thousand head of milch cattle had died from this disease in some of its forms in the suburbs of Calcutta, and the Government Commission appointed to investigate into the Indian Cattle Plague in 1871 ascertained that, of the cattle kept in the city and suburban dairies, 87·5 per cent of the stock were attacked with rinderpest, of which 55·5 of the number kept, or 62·8 of those attacked, died. “This,” said Dr. Hallen, one of the veterinary members of the Commission, “is the result of an unchecked rinderpest among cattle crowded together

* Report of Indian Cattle Plagues Commission, 1871.

in unventilated sheds and surrounded by insanitary influences of all sorts." The Commission reported that, "the state of the byres of Calcutta affords the best illustration possible of the evil effects of crowding. When disease enters these sheds or byres, it does not leave a single susceptible animal unattacked, dairy cattle are kept pent up closely in confined sheds, and the stock is periodically renewed, and if a new purchase brings disease, it spreads unfailingly among the rest." The Commissioners might have added that when disease once enters such a byre it never leaves it, but remains lurking in the soil, in the walls, and in the very atmosphere, waiting the entrance of new victims; for Dr. Hiram Farrell, M. R. C. V. S., says:—"The disease is highly infectious and contagious; the virus can be transmitted in various ways. The excrement which drops from a diseased animal is highly charged with the poison; in fact the very air in the neighbourhood of cattle-sheds with infected animals is poisoned." Now we know as a fact that when the disease has been present in these byres, even though the owner may have lost half his stock, he makes no attempt to disinfect the place; how could he indeed—for nothing short of burning down the filthy sheds and digging out the foundations, could ever disinfect such a thoroughly corrupted mass.

A significant proof under the author's own observation that the gowalla sheds are *foci* of cattle-disease is given by the fact, that of a large number of municipal cattle attacked with cattle-disease during 1878 and 1879, only those working in the gowalla quarters suffered, while others working in other parts of the town were exempt.

We now come to the important question of the milk-

supply derived from cattle kept under these conditions, and it must be admitted that, in a country like India, where milk forms an important item in the food, not only of the infant, but of the adult population, this is one involving sanitary and economic considerations of the highest importance; that the health of the cattle kept pent up in close cow-stables is largely affected by the keeping of dung in about the stables, is clearly shown by the result of investigations made by Dr. Ballard during an epidemic of cattle-disease near London. It was found that only eight out of thirty-one stables inspected, in which dung or urine was *not stored*, had had cases of disease, whilst *eight* out of *eleven* in which dung *was stored*, had the disease; and on another occasion, cattle-plague was found in 66 *per cent* of the sheds in which dung was not stored, and 91 *per cent* in those in which it was kept.

How much of the preventible sickness and mortality in our towns might not, with some reason, be attributed to the unwholesomeness of the milk-supply resulting from the filthiness of the cowhouses and their surroundings, and the carelessness and malpractices of the milkmen, is a question which merits serious consideration on the part of our officers of health and sanitary officials. Medical testimony at home and in America is almost unanimous on this subject, and it requires no medical knowledge or training to understand that the state of filth in which the cows are kept, the prevalence of disease amongst them and their attendants, the filthy and unnatural means by which it is well-known they are forced to yield their milk in increased quantities, the foul atmosphere of the sheds where the milk is

drawn and often allowed to stand, and last, but not least, the extent to which, and the sources from which, the milk is diluted and adulterated before reaching the consumer, are all conditions incompatible with a pure or wholesome supply.

It is well-known that milk is more easily tainted than any other liquid by smoke, gases, and foul odours, and a familiar illustration will present itself to many of my readers who must have occasionally observed, that milk, which has been kept standing in a cook-room where native servants have been smoking the hookah, has attracted and absorbed the tobacco smoke to such a degree as to make it undrinkable even in 'tea.' Milk exposed to the vapour of carbolic acid or kreosote will soon taste strongly of those substances, and if kept in any badly-ventilated place or exposed to sewer or drain emanations, will rapidly become tainted and unfit for use. A recent sanitary writer says: "The great danger attaching to milk as a carrier of disease, depends upon its remarkable powers of absorption, and the rapid fermentive or zymotic changes it undergoes when it becomes mixed with putrefying matter or tainted with disease germs."—*Wilson*.

Parkes says, that milk from diseased animals soon decomposes; and Wilson states, that the milk of animals suffering from foot and mouth disease (epizootic aphthœ) produces aphthous ulceration of the mouth and gums, with swelling of the tongue and great foetor of the breath. Mr. Power considers that garget, a well-known and common affection of the udder of the cow, will so change the character of the milk that the partaking of it induced diphtheria in the human subject.

Now it will be apparent from the foregoing description of the native cowhouses that every element of pollution exists in its most aggravated form, and that in fact it is impossible for untainted milk to come from such sources. But the greatest danger to the consumer undoubtedly exists in the extent and manner in which the milk is diluted and adulterated before sale. I have had it on evidence before myself in a judicial proceeding that the witness, a milkman, having a large and respectable circle of customers, and who, therefore, claimed to sell quite a superior quality of milk, invariably added at least three seers of water to every nine seers of milk, and several milkmen admitted that they not only watered their milk freely, but added to it without scruple the milk from diseased cows, so long as they continued to give down their milk at all.

Hurro Chunder Sen, a gowalla witness, examined before the Cattle Plague Commissioners, stated: "We sell milk in Calcutta, and before selling, add as much water as there is milk. Lall Chand Marik, another witness, said: "Those milksellers to whom I sell my milk, water it, and in order to thicken it, mix with it singhara-nut* flour; the milkmen add water to the milk as long as they can without changing the color." Dr. Tonnerre, Health Officer of Calcutta, says: "The milk is largely adulterated by the addition of chalk, rice fecula, and more or less impure and filthy water."

This depreciation in the nourishing constituents of food is alone a serious consideration, but the real danger lies in the source from which the water, which admittedly

* The water chestnut *Trapa bicornis*.

forms from 25 per cent to 50 per cent of the fluid sold as milk in our towns, is drawn. If the milkman be asked where he takes his water for general use from, he will usually point to the adjacent tank; but if his suspicions be aroused as to the object of the question, he will probably name some well-known and tolerably pure reservoir, or if in the Calcutta suburbs, he will tell you he fetches it from the Calcutta water-supply hydrants; but will any one believe that the milkman, whose conscience is so lax as to permit him to impose upon his customers to such an extent, will be so scrupulous as to the source from whence the adulterating medium is obtained. Can we believe for a moment that he will be so considerate of the public welfare as to go out of his way, transgress the tradition of the elders, and actually go to expense and trouble to procure filtered water with which to carry out his nefarious practices, when the tank is within two steps of his cowhouse door? Credat Judæus Apella! The water of the tank, when the surface scum is swept aside, though laden with sewage constituents, is passably clear. It will in no way discolour the milk when judiciously added, it will not perceptibly taint it before sale, and it is close at hand. What cares he that his cowhouse drains into it that as a Sanitary Commissionier lately reported: "The banks are loaded with dung in every stage of decomposition;" that his house sink soaks into the bank; that his own and his neighbours' privies stand close to the margin; that the children openly and habitually, and adults very frequently, defæcate on the slopes; that the whole surrounding population bathe and invariably urinate in its waters whilst bathing. He cares for none of these

things; why should he indeed? His father and grandfather before him never cared. He has been brought up in these ways and amid these surroundings from infancy. He has never, so far as he knows, suffered from them; why, therefore, should others. He looks upon the visits of Health Officers and Sanitary Officials as an intrusion, their calls for amendment as an oppressive and uncalled for exercise of authority, ways and means of lessening his profits from his trade. Let it not be supposed that the picture I have drawn above has been highly colored or overdrawn; these things are all matters of evidence; they exist to this day, and so long as they continue, they will be a lasting reproach to the local authorities concerned.

Now what say medical authorities and sanitarians to the results of this state of things. Can any human being, with ordinary common sense, believe that *poison* can thus be widely distributed in such an apparently innocent vehicle as milk, and yet no evil result; that the virus of disease can be introduced into our homes, into our daily food, into the principal aliment of our infants and yet no danger arise. There is strong evidence to the contrary. Wilson says: "As regards the spread of specific disease, there is now an overwhelming amount of evidence which proves beyond dispute that milk is largely instrumental in propagating scarlatina and enteric fever. The English Medical and Sanitary Reports contain numberless cases of serious outbreaks of disease which have been thoroughly investigated by such competent authorities as Ballard, Russell, Murchison, Netten Radcliffe, and Simon, and in which the spread of the contagion was distinctly traced

to the milk-supply; and in nearly every case there was undoubted evidence of the fact that even where the milk had not actually been diluted with foul water, the water used for dairy purposes and in which the vessels were washed was contaminated by fæcal matter.

Now, if the danger be so admittedly great in England, where the vessels used are usually of well-glazed pottery or a bright, unabsorbent material, such as tin, how much must it be intensified in this country, where the milk is kept and carried in the rough, porous, absorbent clay vessels in general use.

Yet although almost every medical journal published in England, every work on sanitation, European or American, which issues from the press, contains articles of interest and reliable evidence on this subject; although the Army Sanitary Commission has called attention to it repeatedly, there seems to be a strange apathy on the part of the sanitary and medical authorities in this country in regard to an evil which must be far greater than it is in European towns. The only reference to it that I have been able to discover is a remark by Dr. Fabre Tonnerre, for many years Health Officer of Calcutta. In his Report for 1872, he says: "The state of things above described not only discloses an unparalleled state of unhealthiness, but also makes it a question for consideration whether the milk from cows congregated in these places, which is largely consumed by both rich and poor, does not contain the germs of many of the diseases which decimate the native population of the town." Again, "whether the milk derived from cows in contaminated places and from diseased cattle, which is besides largely adulterated by an addition of chalk, rice

fecula, and more or less impure and filthy water, acts injuriously on the economy of man and developes the germs of disease is a question which I cannot treat in this Report, but there is no doubt in my mind about the question but that it is so;" but though the writer thus expresses his conviction, I cannot find that the matter was dealt with in any other form. I have searched in vain the reports of the Sanitary Commissioners of Bengal for any allusion to the subject, and I can only attribute their silence to ignorance of the existence of these monstrous evils; in fact a late Sanitary Commissioner, who was taken by the writer to visit one of the worst of these gowalla busties, said, he could not have conceived its condition had he not seen it with his own eyes, and after a thorough inspection, he remarked, alluding to the recent death of two well known medical officers, from that fell disease: "Well I can *now* understand how poor Doctors ——— and ——— fell victims to cholera."

That the difficulties in the way of dealing with these monstrous evils are very great, none know better than myself, and I admit that they have hitherto baffled all our attempts at reform, but they are too great when connected with the metropolis of the country for any local authority to deal with successfully: only combined and determined effort can remedy them, and this without the aid and insistence of the Local Government is almost hopeless. The one point to be recognised is, that all such cowstables must be removed beyond the populous part of the town, and wherever located, systematic inspection and sanitary regulation must be insisted upon.

All cow-stables or byres must be paved with stone or brick-on-edge laid in cement. Wood is too absorbent, and is apt to be attacked by white-ants; asphalte is not sufficiently firm to bear the constant stamping of the cattle, which, it must be remembered, are never allowed out of the house and is also too soft, the inside of the cowhouses having always a high temperature. Proper drains and reservoirs must be insisted upon; urine and dung must be regularly removed; but as regards the latter, only such portion need be taken away as the gowalla and his family are unable to work up daily, and dry into cakes or *gointahs* for home consumption and sale, *bois de vache* as it is termed in France, being the universal fuel of the poorer classes: no tank or pond should be within fifty yards of a cowhouse, and no surface drainage should be permitted to enter a tank. There should also be a law against adulteration or dilution of milk and for the regulation of cowstables and dairies. The short enactment passed in England in 1879, and known as "The Dairies, Cowsheds, and Milkshops Order of 1879,"* would be an useful model for imitation; it contains all that is necessary and nothing that any reasonable person could object to.

* Issued 4th February, 1879.

CHAPTER VII.

“ Bound in the shambles in the ghastly row,
Midst all the anguish of departing life,
With glazing eye, and sad convulsive throe,
The fated ox dies 'neath the ruthless knife.”—*Anon.*

Slaughterhouses, as conducted in this country, are generally a source of very serious nuisance; where owned and managed exclusively by native butchers they are, as a rule, offensive beyond all conception, and even when under the charge of Government officials, they are occasionally sufficiently offensive as to come within the meaning of the term ‘public nuisance.’

In one of my official reports I find the following note on the state of a Government slaughterhouse not a hundred miles from Calcutta. “The slaughterhouse is an open brick-built building on the banks of the nullah; it has a plain tiled floor with a central drain; the animals are thrown down on the floor and slaughtered over the drain through which the blood flows to the nullah; the floor is out of repair, and the drain is so dilapidated that deep holes have formed through the masonry to the clay foundation beneath, and the blood soaking into these, and into the open joints of the brick-work, putrefies and gives out a most offensive smell.

“There is no proper arrangement for the removal of garbage and offal, and the vicinity is haunted by pariah dogs, adjutants, vultures, and crows. There was no screen

either on the river or road sides, and the place was most offensive, not only to the olfactories, but to the sight."

It would hardly be credited that this place was permitted to remain for years with a public thoroughfare on each side and within a few hundred yards, and open to the view of one of the principal fashionable drives of the metropolis, but this was a very minor instance of what slaughterhouses in India were before sanitary reforms were insisted upon.

I need not disgust my readers by giving a detailed account of the old native shambles at Narcoldangah and Kurayah in the suburbs of Calcutta, which would be a most appalling picture, though the author can aver from his personal knowledge, he having been instrumental in their suppression, that it could hardly be exaggerated; they have been swept away, and are no longer a disgrace to the metropolis of British India.

Filthy slaughterhouses, wherever situated, must be most injurious to public health, owing to the large collections of offal constantly undergoing putrefaction, the continual flow of blood, urine, or fæcal matter: and in India the climate, the want of proper drainage and very often the want of water, together with the slovenly habits and total disregard of cleanliness on the part of the natives render strict supervision most necessary to secure clean or wholesome food, and prevent slaughterhouses from becoming nuisances.

The nuisance arising from slaughterhouses may be mitigated by the following arrangements, which should be insisted upon:—

The slaughterhouse floor should be paved with stone flags, or where stone is not procurable, with hard well-

burnt table-moulded bricks set on edge, over a brick flat on a substantial foundation of well rammed concrete; the joints, whether in a stone or brick floor, should be made perfectly close with cement, the concrete being made either with cement or hydraulic lime. In New York plank floors are universally used; they are made of resinous pine well fitted and with joints caulked like a ship's deck, and are said to be durable and cleanly; where there is a centre drain, it should be of stone or brick, and the floor should be laid nearly level with hardly any slope, as it is less slippery and cannot be cleaned down without careful washing and sweeping, which should be insisted upon. Every slaughterhouse should have a sufficient supply of good water; this is essential, and no slaughter-house should be permitted where this cannot be secured.

The more open the sides are to allow free circulation of air the better, but the sides should be closed with wire-netting to keep out carrion birds. The pillars and walls should be well lime-washed once a month, and the drains and floor should be constantly scrutinised, and the slightest opening of joint cemented at once.

Nothing in the shape of nuisance is so offensive as the smell of putrid blood. The drain should be led into a reservoir, and the blood either carted away with the offal or buried in trenches where land is available.

The Calcutta Justices' Abattoirs* (from the French

* The five abattoirs of Paris are those of Roule, Villejuif, Grenelle, Menilmontant, and Montmartre containing in all 240 slaughterhouses. They were established by a Decree of Napoleon the 1st, 1810, and were opened in 1818.

abattre, to knock down) are models of what such places in a large city should be, and will well repay a visit. About 230,000 animals are slaughtered there annually.

The manner of slaughtering, as practised by Indian Mahomedan butchers, is very revolting, the animal being thrown on the pavement of the slaughterhouse, and the head being bent round over the shoulder, the throat is cut with a long sharp knife. It is a piteous sight to see a long line of helpless beasts lying in dumb terror, waiting their turn, and it is a matter well worthy the attention of the Society for Prevention of Cruelty to Animals.

It is quite a mistaken idea that pole-axeing cattle, as is practised in Europe, and which is undoubtedly the most humane method, would be obnoxious to any religious scruples of the Mahomedans, so long as the throat was immediately cut and blood followed the knife.

No doubt it would be difficult to overcome the prejudices, and root out old custom from the mind of the Bengali Mussalman, but where there is actually no authority for the prejudice, and where there would be no real breach of any religious command, blind prejudice should never be permitted to stand in the way of sanitary reform or the calls of humanity.

It is true that in New York the same method has been, it is said almost universally, adopted, having been apparently copied from the Jews, who form a no inconsiderable part of the population; but there the cattle are taken into the slaughterhouse *one by one*. A slip noose being then passed round one of the hind legs, the beast is hauled up, till the fore legs are off the ground,

the head being then turned till the nose and horns both touch the ground, the throat is cut with one sweep of a long keen knife, and it is claimed that the animals neither struggle nor show any sign of suffering until the convulsions of anæmia set in, when the brain is depleted of blood and consciousness must have already vanished. (Buck II, 404.) This may be so, I suppose no one can say positively, any more than they can tell whether or no the criminal's head decapitated by the guillotine retains consciousness, as some think, after it is severed from the body.

CHAPTER VIII.

“ Ignorantione rerum bonarum et malarum maxime hominum vita vexatur ”—*Cicero*.

(Through ignorance of what is good and what is bad, man's life is greatly disquieted.)

The rapidity with which vegetation of all kinds springs up on any waste piece of ground or drain side and the luxuriant growth to which it speedily attains in the moist steamy atmosphere of lower Bengal is really marvellous, nor is its rapid growth more a marvel than its vitality.

Opinions differ somewhat as to the effects of growing jungle in regard to health ; but there is a commonly received, but erroneous, opinion, that it is productive of malaria, and it is constantly said of such and such a locality, “ Oh ! how can it be otherwise than feverish and unhealthy, when it is full of rank jungle,” or “ all that rank vegetation must breed malaria.”

Now these beliefs are *right* and they are *not right*. Right in so far as they connect the existence of rank vegetation with the presence of malaria, not right in so far as they *attribute the malaria* to the *presence of living vegetation*. The rank vegetation is the *effect* and not the cause: it is in truth a sign of malaria, an evidence of the presence of miasmatic conditions.

Growing vegetation in fact lives and thrives on the very exhalations which are so noxious to animal life. Plants absorb their nutriment through both their roots and their leaves, the latter of which may be considered as their lungs. As animals *exhale* carbonic acid, ammonia, and watery vapour, so plants *inhale* these very elements, and by this means purify the atmosphere, whilst under the magic influence of the sun's rays they *exhale* oxygen and nitrogen, the principal components of pure atmospheric air; the action of solar light being to decompose the carbonic acid so inhaled, and to separate and free the oxygen, leaving its other constituent carbon, which is insoluble, behind in the substance of the leaf.

This decomposition of carbonic acid takes place in the cells containing chlorophyll, a resinoid body consisting of phylloxanthin (a yellow) and phyllocyanine (a blue) to which the green coloring of plants is due.

As Prof. Max Von Pettenkofer tells us,—“If the drainage of human habitations remains in soil destitute of growing vegetation, further decomposition sets in, and other processes are induced, not always of a salubrious nature, but often deleterious.” It is only the action of the living and growing vegetable which recomposes the products of decomposition and carries out to its consummation the process of disinfection, and Professor Daubeny, (Oxford Professor of Botany,) says of vegetable life that “it acts as the appointed instrument for counteracting the injurious effects of the animal creation upon the air we breathe, not merely by restoring to it the oxygen which the latter had consumed, but also by removing, through the agency of the ozone it generates,

those noxious effluvia which are engendered by the various processes of putrefaction and decay."

Growing vegetation is, therefore, to this extent a *benefactor* and *not an enemy*; and the attention of the sanitary authority should be directed not so much in the way of *cutting down* and *destroying* vegetation as in amending the *conditions* under which such vegetation abounds, and which encourage its rank luxuriance, it being remembered that vegetation flourishes not in proportion to the organic matter in the soil, but to the activity of the fermentative changes taking place in it; and that the three necessary factors for inducing these changes are heat, air, and moisture.

The following extract from one of the most complete and valuable recent works on hygiene and public health, edited by Dr. Buck of New York, beautifully illustrates this theory:

"The living vegetable has nothing to do with the production or evolution of malaria, but would rather seem to be concerned in its destruction.

"By viewing malaria as an element in the production of plant-life, exhaled from the soil and absorbed by the myriad pores (stomata) which leaves present, mostly on their under-surface, we have an explanation of the luxuriant vegetation that usually indicates its habitat. During the day under the stimulus of light and heat, vegetable nutrition is active; carbon is fixed, oxygen is thrown off, and malaria absorbed to act its part in the organism. Hence the comparative freedom from malarial poisoning conferred by sun-light. During the night, on the contrary, the plant sleeps: its nutritive functions are at a stand-still, and the unabsorbed malaria envelopes

the foliage in a rich vapour until the morning sun rouses up the organism to profit by it."

There are, however, three ways in which such vegetation acts injuriously, and consequently three reasonable arguments in favor of its clearance.

First, that it gives cover to venomous snakes, reptiles, and vermin, and encourages the propagation of mosquitoes and such *small deer*.

Secondly, that it keeps the rays of the sun from the surface of the soil, thus preventing free evaporation and drying of the surface, and maintaining a humid and malarious condition of the atmosphere; and

Thirdly, that when it has passed its maturity, it dies down, decays, and decomposes.

In addition to these three objections there is this one, that in towns it gives cover for the commission of nuisances, and therefore is, if not a nuisance in itself, a cause of nuisance.

While admitting, however, that there are on the above grounds good reasons for the clearing of jungle, such clearances should not be made indiscriminately or otherwise than under proper supervision. To cut down (as is too often done) the vegetation on waste lands and there to let it lie and *rot*, is but to produce the very evil we are trying to remedy.

It is a fact generally known to all residents of our Hill stations, that the annual cutting down or *breaking down*, as is too often done, of the rank jungle growth on the hill sides during or after the rains, is followed by more or less prevalent diarrhoea.

To cut down the ordinary undergrowth of *bun kochu* (wild caladium or arum) and *bherinda* (a species

of euphorbia) and which abound on all waste lands in Lower Bengal, at the beginning or the middle of the rains, is *worse* than useless, the jungle springs up again and the cut plants rot on the ground. The proper time for jungle-cutting is either from the beginning of the hot weather or after the complete cessation of the rains. Then the vegetation should be thoroughly cut down, and after being allowed to dry for a few days should be burnt on the ground, which should be dug over so as to turn up and destroy the roots. Cut, or rooted up plants, and *pannas* or water-plants, should never be allowed to rot on the ground, it being always kept in mind that it is the decay of vegetation, and not its growth, that produces malaria.

But this process will be ineffectual in altering the malarious characteristics of the locality, unless the land be properly drained and kept clean and free from excretal deposits and other filth. All unused waste lands in towns should be planted with trees, care being taken to select such as discourage undergrowth and yield a pleasant shade without entirely excluding the sun's rays. Aromatic and flowering shrubs and trees also aid in the production of ozone.

In the chapter on arboriculture will be found some hints as to the kind of trees and shrubs most suited for urban planting, both as regards ornament and purification of the atmosphere.

CHAPTER IX.

“The Commissioners shall provide all establishments, cattle, carts, and implements required for the removal of offensive matter and rubbish.”—Sec. 193, Act V of 1876. (B. C.)

One of the principal duties of the Municipal Conservancy department is the regular collection and removal of house and kitchen refuse, refuse from markets, shops, and handicrafts, the litter and dung from stables, and the street dust and droppings of animals in the thoroughfares. The cleansing of the streets is a matter of far greater importance than is generally recognised. It affects the public health and the comfort of the community to an important extent. In most towns it is customary to have certain fixed hours, within which such matters may be deposited outside the gates of compounds and houses, on the side of the thoroughfare from whence they are removed by scavengers' carts. Nothing presents so repulsive an appearance, or is so conducive to the production of foul smells and noxious exhalations as garbage heaps left on, or unremoved from the roadsides, it is, therefore, incumbent on every Municipality to maintain a sufficient staff of carts and scavenger coolies to keep the streets clean and remove daily all such accumulations. In most Municipalities in Bengal* bye-laws framed under section 313 of the Bengal

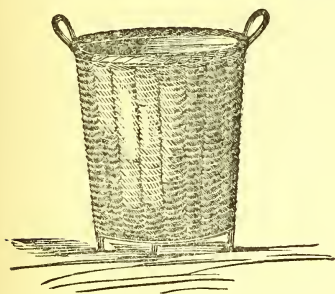
* The Bengal Acts have alone been referred to, but there are similar provisions in all local enactments relating to Municipalities.

Mofussil Municipalities' Act prescribe the hours (usually from 8 P. M. to 8 A. M.) within which refuse may be deposited, and these bye-laws should be strictly enforced for the general comfort and health of the inhabitants. In some towns fixed dust-boxes are placed in the streets, but they are not to be recommended: they are unsightly and soon become *foci* of filth and foul smells.

Dr. Janes, of New York, one of the Sanitary Inspectors of that city, says, "The garbage-box is another nuisance which deserves particular attention: they are generally placed on the side walks, and are either constantly full or never completely emptied. Very few of them are without signs of demolition, many have but three sides, some but two, and not one in the whole district has a cover. It is not unusual to see these boxes day by day receiving their accustomed load until filled to their utmost capacity, the gutter receiving the surplus, which forms a temporary dam, allowing the collection and retention of foul water. No effort is made to thoroughly empty these boxes, consequently more or less foul matter adheres to their bottom and sides, sending off an odour more disgusting, if possible, than it was before the mass was disturbed; thus the boxes become so completely saturated with the liquid portion of their contents, that they become themselves a source of disease."

The deposit of garbage on the road sides and streets is also most objectionable; in the rainy season especially a considerable amount of effete organic matter is washed out of the heap and either carried into the drains or spread over the road surface, giving rise to mephetic odours and adding to the impurity of the atmosphere.

A simple and efficacious remedy for this evil would be



to compel every householder to place his house-refuse on the roadside in a tub, box, or *basket*, *leaped inside with clay or cowdung*. Such baskets are now, or were a few years ago to the writer's knowledge, used

in Bombay for the removal of nightsoil, the scavenger can then empty them directly into his cart, and the road sides would be kept free from the disgusting nuisance now prevailing in Calcutta, the suburbs, and elsewhere. The form of scavenger cart principally in use is a light two-wheeled tip cart, with shafts, drawn by a pony, galloway, or bullock, very much like the ordinary farmer's cart used in England, but altogether smaller and lighter so as to be adapted for the light cattle procurable in this country, having a carrying capacity of about 30 cubic feet, but if fitted with side rails capable of carrying a *higher* load of straw or light refuse such as leaves, litter, grass, and the like.

The universal manner of disposing of town refuse in this country is by throwing it into holes, pits, ponds, or low grounds which thus in time are raised to the surrounding level, and reclaimed. This practice has given rise to great controversy, some medical authorities condemning it in the strongest terms, while others are just as positive in its favor. For instance, Dr. D. B. Smith, late Principal of the Medical College, and formerly Sanitary Commissioner for Bengal, says, "There is another conser-

vancy arrangement 'which is deserving of the strongest condemnation.' I allude to the practice of filling up hollow places, broken ground, and even tanks with the off scourings and filth of the city. Probably no more certain method of generating and perpetuating cholera could be devised than this said filling up of old tanks with decaying organic matter." Referring to the proposal to carry out all the sweepings of Calcutta to the saltwater lakes, Dr. Smith says, "I believe it will prove a gigantic and intolerable nuisance. I cannot believe that all the abominable sweepings of Calcutta could be deposited within two or three miles of its eastern boundary, (on land *liable* by chance to be flooded) without ere long creating an atmosphere of putrefaction and foetor such as would drive the inhabitants of Entally either into the law courts, hospitals, or graveyards." This opinion was given in 1869, since which time the very practice condemned by Dr. Smith in such strong terms has been in force, and Entally still stands where it did.

The practice has been in vogue in the suburbs of Calcutta for years, and no evil results have ever been experienced beyond temporary inconvenience. The present Surgeon-General of Bengal, when Health Officer of Calcutta, and who himself followed the practice, says, "Respecting the use of road-sweepings for filling tanks, I find that for some years past, the Sanitary Commissioner for Bengal, Dr. Coates, has adopted it in all provincial municipalities; and the Officiating Sanitary Commissioner, Dr. Lethbridge, urges its continuance during his incumbency. The practice is common in European towns."

Harmless though the practice may be however, so far

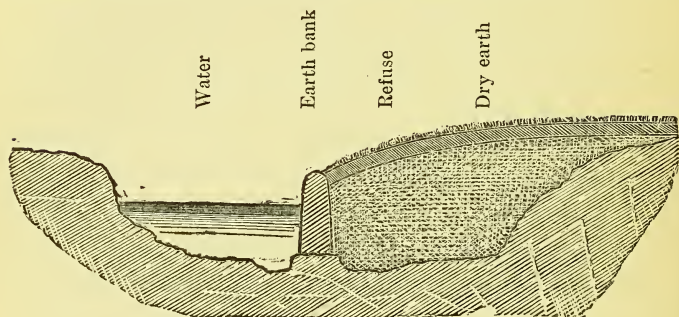
as its being a direct producer of disease, it cannot be said to be altogether inoffensive; so long as the sweepings and refuse are *dry*, no great offence is caused; but during the rains when the hollow gets filled up with water, or if the stuff is emptied into a pond already containing water, the result is often the creation of a serious nuisance. Where it is so, however, it may, in nearly every case, be ascribed to want of care on the part of the persons in charge, for where proper precautions are taken, the deposit of sweepings in tanks, even in populous localities, has been continued for several years without giving rise to serious complaint, or to any known outbreak of sickness, and where any very offensive smell has been caused, it has generally been traced to the improper deposit of dead animals, or night-soil into the hollow.

Where a deposit of the kind becomes offensive, the only remedial measures which are of any real service are, at once to cover the deposit with a good coating of fresh earth, and where there is a collection of foul water at the bottom of the hollow, the addition of a few gallons of cold saturated solution of alum will cause the organic matters in suspension to be precipitated, after which milk of lime may be added, and the air may be cleared of offensive vapours by burning a small quantity of sulphur.

In commencing to fill up such hollows with town sweepings, therefore, the following rules should be attended to.

Do not commence to fill any tank unless the department can guarantee the completion of the work by the setting in of the following rainy season. This is easily as-

certained by the following calculation. Carefully measure the length, width, and depth of the hollow, and ascertain its cubic capacity; then take the number of cart-loads of refuse available in that locality per day, the number of carts multiplied by their average cubic contents, will give the daily amount available, and this multiplied by the



Tank partially filled with refuse.

number of days from the date of commencement of the work up to the 15th June following, will give the total amount. Where a larger pond or hollow is to be filled than can be done in one season, it should first be divided into two sections, by an earthen bank, wall, or diaphragm, so as to keep the sweepings in the filled up portion from contact with the water in the other, as shown in the sectional sketch above. *2ndly.*—All water should be pumped or baled out of the hollow before the filling up is commenced. *3rdly.*—No dead animals, slaughter-house garbage, or fæcal matter should be thrown into the hollow. *4thly.*—A sufficient quantity of earth should be carted to the spot or excavated from the bottom or sides and kept in a spoil bank for use in covering the deposit when finished, or *at any time* should it become

offensive. The following suggestions which were framed by the writer for the use of the municipality, of which he has charge, and which were approved of by the Commissioners and the local Government, may be found of use as a guide to others, and are, therefore, quoted in extenso.

The filling up of existing holes, pits, and low swampy lands.

“ Here the municipality may come forward and help landlords and tenants, and in order to do so effectually, I have to propose the following arrangements for filling small holes and pits and raising low swampy lands within *bustees* and other parts of the township for the mutual advantage of the municipality and the rate-payers. At present not only does the municipality make nothing by the sale of town sweepings; but it is often put to some difficulty to find convenient places of deposit for them, so that the carts have often to travel considerable distances to dispose of their loads and thus waste time.

“ One of the objections to the disposal of sweepings within the town is the difficulty of getting earth to cover the deposit. This can only be met by having earth dug before-hand from the spot where the sweepings are to be thrown. This at first sight would appear somewhat useless waste of labour or somewhat like the Irishman's effort to lengthen his blanket by cutting a piece off the bottom to sew it on to the top; but when it is considered that a trench forty feet by five, by five, will give 1,000 cubic feet of earth equal to a surface area of 1,000 feet, if spread one foot thick, it will be seen that the plan can be advantageously carried out. Then supposing we have a

tank of, say, 100 feet long, by 60 feet wide, and average depth of 12 feet to fill up, it would be necessary to cut a trench 10 feet wide by three feet deep all round the tank, as $320 \times 10 \times 3$ which will give 9,600 cubic feet of earth, sufficient to cover the area of tank *and excavation* one foot in depth, while 100,000 cubic feet of rubbish, allowing about 25 per cent. for settling, will be required to fill the tank.

“As the owner of the land would be a very considerable gainer in the improvement of his property, the municipality might fairly charge him say Rs. 100 or about Rs. 16, per 1,000 feet of surface reclaimed. I would make this charge where the tank was over 8, and not exceeding 12 feet in depth, but where less than 8 feet, I would lower the charge to Rs. 10 per 1,000 superficial feet.

“The charges should in all cases be made in advance.

“The work of excavation, levelling, and dressing should be done by the establishment coolies in the afternoon, under the supervision of the overseers, and should be paid for as overtime work at regular earth-work rates; the overseers, jemadars, and peons being paid a percentage of the amount in proportion to their respective salaries. In order to stimulate the cartmen to work quickly, I would propose to pay them a small sum, say one pie per cart load deposited, a regular tally being kept.

“The advantage to the municipality would be the more expeditious and complete cleansing of streets, the removal of refuse from courts and by-lanes where it now often lies untouched, the increased healthiness of the town resulting from this, and from the suppression of so many sources of malaria, the increased value of taxable property, and the general benefit to the rate-

payers in having filthy holes and ponds reclaimed at a reasonable cost, and lands now profitless, made available for tenants or building purposes.

“The value of the sweepings may be put out of the question at present, as they are now of little or no profit.”

The advantages gained may be thus summed up.

1st.—A large number of malaria, fever, and cholera centres are obliterated from the map.

2nd.—A source of danger to children and even adults is removed from the heart of the bustees and the sides of the highways and thoroughfares.

3rd.—Valuable sites for either building, trade, or cultivation purposes are acquired at small cost.

4th.—The municipality has facility for disposing of the street refuse without the expense of a long lead.

5th.—A considerable amount of assessable property and consequent increased rates is acquired.

In the suburbs an area of one hundred and sixty biggahs, or over 54 acres of land has thus been reclaimed, the value of which would not be less than Rs. 200,000 (two lacs of rupees).

Where lands have been reclaimed in the manner above related, the local authority should place a decided veto against their being used as building-sites or bustee settlement for at least four to five years, during which interval they may be used as grazing ground, gardens, or plantations. After four or five season's cultivation they may safely be built upon, by huts or light structures, which will not require deep excavations to put in foundations. The local authorities in Bengal have ample powers under the Bengal Municipal Acts to control

settlement on such lands, and this is a matter that should be insisted upon in all cases.

Street-watering or sprinkling is an important aid to public comfort in towns during the dry and hot season : it not only helps to cool the atmosphere by evaporation, but it lays the dust and prevents it from blowing about, not only to the annoyance and discomfort of the inhabitants, but to the detriment of their health and deterioration of their household property. When we consider what street dirt is composed of, being not only inorganic detritus but bullock and horse droppings, garbage, sewage, and even excreta decomposed by heat and moisture, we can easily understand that even more serious dangers to health may be feared than the bronchial irritation produced by inhaling particles of sand, granite detritus, and other irritating substances, while every Indian house-holder is well aware of the ruinous effects of dust upon furniture and other household appurtenances.

I am not, however, oblivious to the fact that there are strong advocates in favor of dry sweeping of streets instead of intermittent moistening, and their arguments are not without reason. One Indian medical man in a recent note on the sanitary condition of Calcutta says, " Better have the *well dried innocuous dust* of the roads swept up and collected by *dhangurs* than fertilise the organic germ-cells of disease by systematic watering." This is no doubt true so far as it goes if the *well dried dust* be really innocuous, and secondly if it were possible to have it completely and thoroughly removed by sweeping. In America where these questions are dealt with in a much more thorough manner than

with us, many sanitary authorities condemn the practice, though others are as strongly in its favor.

Dr. Janes, a Sanitary Inspector of New York city, says, "The practice of sprinkling the streets during the warm weather thereby increasing the humidity of the atmosphere and hastening the decomposition of whatever organic matter may remain on the surface is one directly at variance with the present state of sanitary science. If the streets be regularly and thoroughly swept, they will require no sprinkling; otherwise better suffer an occasional inconvenience from the dust than be constantly inhaling the miasm arising from this practice."

Dr. Furman, another Sanitary Inspector, says, "The habit of sprinkling the streets with water during the heated term is pernicious and becomes a prolific source of malaria;" and Dr. Burrall also an Inspector of the same city says, "Streets will have the least injurious influence upon the public health when clean, dry, and wide, and running in such direction as to catch the prevailing winds. In order to appreciate fully the unhealthiness of dirty streets, it must be remembered that street dirt is composed to a great extent of organic matter. Under the influence of moisture and the rays of the sun, this matter is constantly undergoing decomposition, as moisture favors the production of organic changes; streets should be kept so clean as to require but little sprinkling, as this, in the opinion of some of our most prominent physicians, only lays a dust which should be carried out of the city instead of being left to form one of the materials for the generation of malaria."

In fact there is a general concensus of opinion on this subject amongst the Sanitary Inspectors of New York, a city containing between 8 and 900,000 inhabitants, and having a most perfect system of sanitary inspection.

But all this testimony goes more to show that street dirt, whether wet or dry, should not be allowed to remain in the streets but should be removed outside the towns; and the theory propounded is, that organic matter, whilst dry or in a state of desiccation, is innocuous, and requires heat and moisture to develope its noxious properties; and here is where the argument on the other side comes in. The dust containing dormant germ-cells, and dried organic particles, it may be, the evacuations of cholera or dysentery, the specific poison of small-pox derived from the skin; of scarlet fever, derived from the skin, throat, and urine; of measles, from the skin and lungs; may be lifted from the ground and driven along by the wind be inhaled, and having thus found their way into the system, will there find the heat and moisture necessary for the awakening of their latent powers of evil.—*Parkes*.

Thus it may be, we have simply the choice between two evils, and therefore of two evils we should choose the least; add the undoubted discomfort caused in the dry season from March to June by the constant clouds of dust to the possible injury to health, and the balance is certainly in favor of street-watering combined with scraping and cleansing.

In India, except in some of the larger cities where there is a regular water-supply with street hydrants street-watering is carried on by water-carts or bhisties

the latter being perhaps the more common, as it certainly is the more primitive; and after experience of both modes, I am inclined to think, that the agency of the bhistie is, especially where tanks are not situated immediately on the roadside, the cheaper and more effectual. The bhistie's *mussuck* or skin bag contains about $10\frac{1}{2}$ gallons, and he can fill it and empty it half-a-dozen times, whilst a water-cart containing 120 gallons is filled and emptied once. The bhistie receives five rupees a month, whilst in addition to the keep of a pony and maintenance of a water-cart, there is a driver on seven rupees and two coolies also on seven to fill the cart. Each bhistie should sprinkle about twelve thousand superficial feet of road surface, working for three hours: a water-cart will sprinkle about twice or thrice the area according to the distance of the water supply.

In many towns street-watering is carried on by voluntary contribution from the inhabitants of the streets watered, and this, where there are no public funds available, is no doubt very desirable, but it is clearly one of the duties of the local authority or municipality wherever their funds will permit.

One of the most frequent sources of pollution of the atmosphere of our towns and villages is the defilement of the waste lands and unoccupied compounds. In this country any piece of vacant land is speedily covered with rank vegetation, and it as speedily becomes the place of deposit of garbage, dead animals, filth, and nightsoil. It is resorted to for purposes of nature by all the low class inhabitants of the neighbourhood, and soon is a focus of foul odours and miasma.

Although the Mofussil Municipal Act contains ample provisions for enforcing penalties against the owners of such lands, it is not always easy to apply them. Many of the owners are absentees, and with others the excuse is, 'other persons defile my land, how can I prevent it?' This excuse ought not to be admitted. If property has its privileges it has also its obligations, and the first of these is that it shall not be a nuisance to the community. A man has no right to retain the ownership of property within a town unless he is able and willing to maintain it in such order as to prevent annoyance and injury to his neighbours. The inclosing of all open and unoccupied spaces within towns, so as to prevent access to them for improper purposes, should be required and enforced, and the owners after due and sufficient warning, should be mulcted in such amount of penalty as will enable the municipality to appoint and maintain sufficient watch and ward to prevent these nuisances. It would have a very salutary effect if, after due notice, the owner of every waste piece of land, which was in such a state as to be a source of annoyance to the public, were fined in such a sum as would suffice to pay for cleansing the land and maintaining a chokeydar for at least three months, the duty of such chokeydar being to warn off trespassers and to arrest any person throwing garbage or filth or resorting thereto for purposes of nature. The ordinary municipal police are seldom sufficient, numerically, to undertake such duties; but a little extra vigilance on their part would seldom be thrown away, especially in preventing the defilement of the roadsides and drains, and open spaces immediately adjacent to, and in view of, the public streets.

CHAPTER X.

“It is the true aim and object of the Sanitary Engineer to assist Nature in her great and simple operations.”—*Baldwin Latham*.

“The defects of the climate of Calcutta during the latter part of the rainy seasons may, indeed, be ascribed in a great measure to the state of the drains and watercourses, and to the stagnant water remaining in the town and its vicinity.”—*Marquis of Wellesley*.

One of the principal insanitary features of Indian towns and villages is their inefficient drainage. In many towns and most villages the drains are simply excavations in the loose soil, running generally along the roadsides, but often where they cross the district, forming the original demarcation of private lands, the tortuous boundaries of which they follow without any reference to the natural fall of the land or to the purpose for which *drains* are constructed.

Their general plan and construction are in most cases faulty in the extreme: they are more or less deep according to the caprice of their original excavators or according to the demand for earth to raise the *pagars* of the proprietors of adjoining lands; their sides have no proper slope to prevent the falling in of loose earth, their bottom no sufficient inclination to permit the water to pass through them with sufficient velocity to carry off the solid filth and prevent deposit and downward percolation.

Weeds and coarse grasses grow on the bottom and sides; field-rats burrow up the banks and throw out heaps of earth; and during the rainy season, it is a common practice for the villagers to place bunds or dams of stakes, weeds, mud, and fish-traps across them to intercept the fish with which every stream of water abounds in the rains: all this tends to obstruct the flow of water in the more rural parts.

In populous quarters further and more serious obstructions occur, especially where Municipal or other local authorities are either careless or lack sufficient means to keep up the necessary establishments, and where supervision is therefore lax and insufficient. Culverts and entrance bridges are constructed with insufficient waterway and of too great length to permit of proper cleansing. Owners of huts often secure and extend their earthen foundations by driving rows of pins or stakes along the course of the drain, and projecting as far into its bed as they dare venture without fear of the sanitary or local authority. Earth is filled in at the back, and is as often as not, dug from the bed of the drain itself, at once destroying its level and leaving a hollow for water to accumulate, and sewage to stagnate in. The next process is to place over the drain a platform or bridge from four to sixteen feet in length, constructed of loose planks, *guran* sticks or bamboos. This may serve either as an entrance to a house or hackney carriage stable, or as a shop frontage. Sweepings, refuse, dust, horse-dung, and kitchen-garbage fall through the interstices; rats honeycomb the sides of the drain underneath the platform, forming an accumulation which effectually obstructs the flow of water in the rains, while in the dry weather the addi-

tion of ablution water, rice-conjee, the washing of vegetables, fish, and domestic utensils, and in the case of stables, the urine of the ponies, or so much of it as is not absorbed by the clay-floor of the stall, help to form a hot-bed of putrid filth eternally seething under the noses of the inhabitants.

Add to all this, the drainage from *pucka* house kitchens, the washings from privies, the decomposing dung and urine from *goals* or cow-byres, the use of the drain sides by passers-by or residents of the locality for purposes of nature, and perchance a dead dog or cat in an advanced stage of decomposition, and the condition of an ordinary uncared for *cutchra* drain may be imagined. In fact they are in too many instances "elongated cess-pools, the most filthy and disgusting nuisances of the town, a permanent source of effluvia detrimental to health and destructive to the life of the inhabitants."—(Calcutta Health Officer's Report 1865.) Of course things are not always so bad as above represented, nor do they always continue so.

During the rainy season, if the Conservancy Department has been moderately active in removing obstructions, the drains are swept by the heavy rainfall, and the filthy deposits either carried off or so diluted as to be comparatively inoffensive. And again, there is generally a period of annual cleansing and excavating, when the silt is dug out and either carted away, or, as too often happens, is spread over the flanks of the road to raise the surface and be desiccated by the powerful rays of a tropical sun.

But here again another evil arises,—the usual manner of cleansing simply aggravates the faulty construction

of the drain. The silt is dug out by ignorant coolies, generally *dhangars*, working under the direction of a *peon* as ignorant as themselves, or of an overseer of no professional knowledge and often but little practical experience, and the depth to which the drain is excavated is regulated more by the quantity of earth required for the *cutcha* road repairs than by the requirements of the drainage. The liquid portion of the sewage which finds its way into these drains, therefore, exposed to the full heat of the torrid zone, with hardly any flow, either evaporates or soaks into the subsoil, and saturates and fouls the foundations of the dwellings of the people, leaving the solid filth to be removed in the form of a black putrescent mud.

Another common fault of drains in Bengal towns and villages is the want of any proper outfall. In many places, notably in the Suburbs of Calcutta, they lead directly into tanks or ponds by the side of the roads. The tanks have been permitted so close to the roadsides that the drains must fall into them, the road surface water and sewage flow into the hollow, until it is filled to the brim, the spill water finding its way through the continuation of the drain on the opposite side (if permitted by the levels, which is not always the case), the pollution of the tank being a secondary consideration in the eye of the owner to securing a supply of water for fish-raising.

In other cases the drains simply lead out into the open country and end in the rice fields or *jullas*, and as these remain throughout the rainy season, and for some time after, full of water, the town or village drainage is headed back and stands in the drains for several

months in the year, and thus keeps up that saturation and humidity of the subsoil and foundations, so inimical to the health of the people. The evils arising from this state of things can hardly be exaggerated ; they are admitted by all sanitary authorities, although, as is usual in such cases, ‘ doctors disagree ’ as to the extent to which the prevailing fevers of Bengal may be attributed to it.

Professor Max Von Pettenkofer’s opinion is, that humidity of soil is a necessary factor in the etiology of fever epidemics.

Dr. David B. Smith, some while Sanitary Commissioner of Bengal, says,—“ There is constant and close connexion between humidity of soil and high rates of sickness.”

The Council of Hygiene of the City of New York reported, after a most carefully-conducted series of hygrometrical observations, “ that any marked degree of excess of humidity in any locality was without exception found to be associated with an excessive constant sickness-rate and with all kinds of contagion and infection.”

Mr. Simon, Medical Officer to the Privy Council, considers that “ an undrained or damp state of soil in populous localities is dangerous to public health, and falls under the legal definition of a nuisance, for which sanitary authorities are responsible.”

I have quoted enough to show that high sanitary authorities view obstructed drainage and consequent water-logging of the soil as being a distinct danger to health and life ; and I will close this chapter with an extract from a very valuable and practical pamphlet submitted to Government by a well-known and greatly respected *zemindar*, whose natural ability was quickened by a liberal education, and whose interest in the sub-

ject was enhanced not only by his natural sympathy for his fellow-countrymen, but by the large stake he held in the country, and the large interest he had in the well-being of the urban and rural classes, amongst whom his tenants were numerous. I allude to the late Hon. Rajah Digamber Mitter, C.S.I.: writing of the causation of the malarial fever which had become fearfully prevalent in Lower Bengal, and especially in the Burdwan District, he says,—“The type of fever met with in the epidemic districts is solely due to a *something* in the soil, and the condition most favorable to the development of that something is *excessive or abnormal* humidity of the subsoil. The cause which operates most powerfully to produce that condition is impeded drainage: it is the inordinate humidity of the subsoil of towns and villages, and not of the *paddy-fields* and *jullas*, which contributes to the outbreak of the fever with epidemic intensity. The fact that the natural drainage of a Bengal town cannot be interfered with, with impunity, which of all others should have forced itself generally into notice, is yet just the one least generally known or recognised, and it is to this ignorance or indifference that is to be attributed the ruin of many once-flourishing cities and towns both in earlier and later times.”

We may thus sum up the insanitary characteristics of Indian towns and villages where the state of the drainage is as above described. Excessive humidity of the atmosphere, stagnant waters, obstructed flow of drainage, water-logged subsoil, damp foundations, luxuriant vegetation, impeded circulation of air, decomposing animal and vegetable matter, and putrid exhalations.

CHAPTER XI.

“Before an Engineer attempts to sewer any town or district, he should enquire how nature has provided for passing off the rainfall and the surplus surface water, and he should interfere with that as little as possible.”—*Rawlinson*.

Where funds are available, remedies are easily found and applied; but impecuniosity, if not absolute insolvency, is the normal state of most of the *mofussil* municipalities in Bengal, and it is not the object of this work to treat of elaborate and complete schemes involving large outlay and great engineering skill; but of such improvements as are within reach of the ordinary municipal purse, and such as can be carried out, if need be, under the supervision of persons possessing but a moderate amount of engineering knowledge; but the first principle to be observed, is that laid down by Mr. Rawlinson, C.B., C.E., M.I.C.E., and quoted above. Where the drainage, therefore, is such as I have described in the last chapter, the following remedial measures must be adopted as far as practicable.

Where possible, a complete series of levels of the different drains should be taken. This should be accomplished without much difficulty or expense, flooded as the country now is with the graduates of our State colleges.

This done, permanent masonry *matams* or bench-level marks should be built at intervals of every 200 or 250 feet, in the bed of every drain; and where drains pass along the basements of buildings, under bridges, and

other permanent masonry structures, bench-marks may be cut or otherwise indelibly marked on their surface, for the guidance of the conservancy staff. It will then be comparatively easy to maintain the level, when the drains are being excavated and silted. A convenient form of level is of importance in making or excavating drains, in fact where there is little fall, the use of a reliable instrument is quite requisite to grade the bottom of the drain at a true inclination, so that the sewage water may flow steadily. The ground surface is often so deceptive that levelling by the eye and random guessings should never be trusted to. The figure (A) as under, represents a

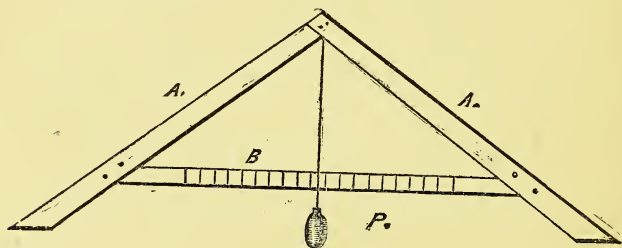


Fig. A.

simple, cheap, but efficient drain-level that any carpenter can make in wood in an hour's time; *A A* are pieces of wood one inch thick, eight feet long, four inches wide at the lower ends and two inches wide at the top; *B* is a graduated cross-bar screwed to *A A*; *P* consists of a plummet and line. Before marking the graduated scale on *B*, let the level be turned halfway round, if the plumb-line indicates the same point or mark, the level is practically correct. The pieces should be planed smooth, painted, and the joints screwed together. Templates are useful for forming the banks or slopes: they

can easily be constructed as shown in figure (B) of any

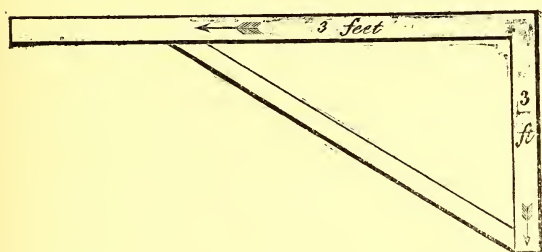


Fig. B.

straight wood, three inches wide, and one inch thick.

Unless the bottom of a ditch or drain is made with an uniform gradient, the earth being soft and readily washed out in some places, and more compact in others, the bottom of the channel would be liable to be gullied where the water runs most rapidly.

No excavation or silting out must be permitted below the level of the bench-marks.

Where a long course of unscientific silting out has lowered the bed of a drain beyond the proper level, it should be raised with sound earth, clay or building rubbish, well rammed and beaten down so as to form a smooth impervious bed. As a general rule, it will be found that the remedy required consists in raising, instead of deepening, the beds of all old cutcha drains.

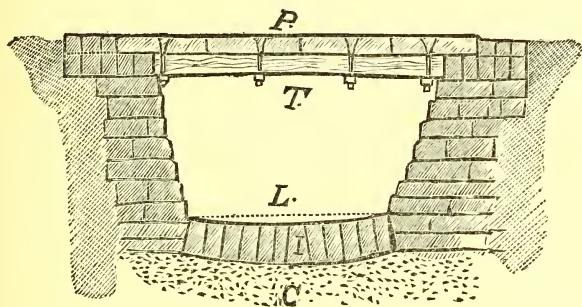
In raising the bed-level of drains, *the work should always be commenced at the highest point of the drainage.* Whereas in excavating or silting, the coolies should invariably *start from the point nearest the outfall, and work up the drain.* Wide mischief is caused by careless, aimless, and irregular excavation of drains at their upper portions, thus often necessitating an undue deepening of

the outfall end if the water is to be allowed to flow off. An ignorant overseer or road *jemadar* thinks he has done a praiseworthy work if he has carefully cut out the bottom and sides of the *cutch*a branch drains in his immediate section, leaving a dry clean bottom and well-trimmed slopes, without giving a thought to the consequences of lowering the bed of the drain at that point, possibly lower than the outfall itself.

All culverts, bridges, and covered ways should be constructed of the full width of the waterway of the drain, and with masonry floors or inverts placed a couple of inches lower than the bed of the drain to permit of proper silting without disturbing the level. Retaining walls and other structures placed alongside the drains must have their foundations sufficiently deep not to be disturbed or endangered by ordinary excavation or silting. All bench-marks, inverts, floors, arches, and other masonry structures should be built of sound, hard, well-soaked bricks, laid with first class hydraulic lime mortar and the joints raked and pointed with cement, composed of one part fresh Portland cement and two parts clean sharp river sand. What is called *cutch*a-*pucka* masonry should never be tolerated: it has no stability, and the bricks being porous, and the mortar mud, or very inferior *soorkee* and lime, the open soft joints soak in the sewage, become intensely foul, and more difficult to cleanse than a simple clay bottom or bank.

Rough piling of the drain sides with wooden or bamboo pins, and bamboo, stick, or rough plank platforms, should never be allowed. The extension of shop frontages into the street is a fraud upon the public. Where bridges are required for access to shops or stables, or

carriage-ways to private houses, they may be constructed with a platform of well-fitted planks, removeable at pleasure, placed over masonry side walls, built with a sufficient batter, and brick-on-edge invert, set on concrete as shown in the following sketch. Such structures are



P. Plank top bolted to.

T. Cross limbers.

L. Level of drain bed.

I. Invert.

C. Concrete foundation.

more expensive at the outset, but they are *necessary* improvements, and not more costly in the long run when renewal, fines, penalties, and *blackmail* are taken into consideration in addition to first cost. Native house-owners are very fond of constructing raised masonry platforms covering in the drains along the entire frontage of their houses. These form lounges facing the street, and serve to conceal what are often very filthy drains.

Not unfrequently the ends of these platforms are enclosed by screenwalls and used as urinals. I have even seen a privy erected over the drain in such a situation. Such constructions should never be permitted: they not only form an obstruction to the drainage, are difficult to clean through, unless of large size, and provided with man-holes at short intervals, but

they tend to reduce the width of the streets and are unwarrantable encroachments on public land, being one of the means by which house frontages are gradually pushed out into the street—first comes the platform, then perhaps a temporary sunshade is placed over it, and if that escapes notice, it is replaced at some future time by a more permanent structure, till after the lapse of a few years, the fact of the original encroachment has been forgotten and the wily Hindu has “enlarged the borders of his tent” and acquired a strip of valuable frontage at no cost to himself and to the detriment of public rights. The Municipal or other local authorities who knowingly permit such encroachments, clearly fail in their duty as trustees for the public.

In forming or improving drains three questions have to be considered: the amount of velocity of the sewage flow required to carry off impurities; the capacity required to carry off the maximum quantity of water falling into the drain in a definite period; and the scouring action on the bottom and sides of the channel.

The velocity depends on the hydraulic mean depth of the stream and the inclination of its bed. The hydraulic mean depth is ascertained by dividing the cross sectional area of the stream by the width of its cross section measured along its bed. Or in other words —

“By dividing the sectional area of the channel by the wetted perimeter, or the *contour* of the wetted channel, we get what is called ‘the mean hydraulic depth,’ or often, ‘the mean radius.’”—*Baldwin Latham*.

Then the inclination remaining the same, the greater the mean depth, the greater will be its velocity.

The sewage flow in *cutcha* drains is, however, great-

ly influenced by the irregularities and roughnesses of the channel, the friction being thereby greatly increased, and the extent of surface with which it comes in contact, proportionately retards its velocity. Drains should not be made of a greater width and depth than is actually required to carry off the highest average quantity of water passing into them.

In considering the amount of fall or inclination to be given to the bed of a drain, it would seem at first sight as if too great an inclination could not be given in order to make it discharge its contents in the shortest possible time, and to wash out all solid filth which with a slow current has a tendency to deposit; but here the scouring action must be taken into consideration, and its effect upon the bottom and sides of the drain must not be overlooked.

In Neville's Hydraulic Tables, &c., it is stated, that "the mean velocity of a stream must not be too quick, and should be so determined as to suit the tenacity and resistance of the channel, otherwise the bed and banks will change continually, unless artificially protected. It should not exceed 25 feet per minute in soft alluvial deposits, and 40 feet per minute in clayey beds. It is true that Neville is here speaking of rivers, the conditions of which are widely different from drains."

A surface velocity of two feet per second will, as a rule, be found sufficient for practical purposes. The surface velocity of a stream may be easily ascertained by measuring a given length along the bank between two fixed points, then throwing a cork or piece of light wood into the stream, the time taken for it to pass from point to point as checked by the second hand of an ordinary watch will give the surface velocity. Summed up

shortly, therefore, the conditions to be observed are, that the drain shall be able to carry off with sufficient velocity the maximum quantity of water or sewage likely to pass into it, but that the velocity shall not be so great as to endanger the bottom or sides.

The efficiency of town drainage depends in a great degree upon its outfall. This may be either into a river, canal, or tidal creek, or into the *jullas* and rice-fields, and in the latter case it follows the natural fall of the country.

Where the drainage falls into a running stream, it is usually easily managed and uninterrupted, except by exceptional causes, such as unusually high floods. When into a canal, tidal creek, or river, it is necessarily intermittent, and the influx of tide water has to be provided against; but where its outfall is into the rice-fields or *jullas*, the storm-water and sewage is often headed back, and the drains remain brimful during the rainy season, the spill water only passing off. This lasts till the water-level sinks by the drawing off of the water from the fields and by evaporation and subsoil percolation.

As the water in the rice-fields is a necessity of the cultivation, we cannot (even were it practicable) propose to drain off these lands; the only way, therefore, to meet the difficulty is to carry the main drainage channel between embankments through the fields and *jullas* till we reach some natural watercourse, at a sufficiently low level, to permit of the water of the drains falling into it. If the watercourse be tidal, a sluice or tide-valve must be provided. If no such natural facilities present themselves, the water must be lifted by steam or wind-power as in the Fen Counties of England and the Lowlands of Holland.

It has often been a matter of surprise to me that such a comparatively inexpensive method of pumping water for drainage or irrigation purposes has not been introduced into this country. In no part of India have I ever seen a wind-mill. In the present day steam-power has almost entirely superseded wind-power in large drainage works; but I can well recollect when wind-engines were in universal use in the Fen Counties. Littleport Fen, with which I was familiar as a youth, having an area of 28,000 acres drained by wind-engines, now superseded by two steam engines of 30 and 40-horsepower. The following account of the great Bedford level drainage will illustrate what great results may be attained by utilising natural forces:—

The Bedford level is a vast tract of about 400,000 acres of lowland, extending into the counties of Northamptonshire, Huntingdonshire, Cambridgeshire, Lincolnshire, Norfolk, and Suffolk. It was formerly dry land, but, from natural convulsions and other causes, it gradually became a vast morass. As early as 1436, the idea of draining these fens engaged attention. Large sums were expended in attempts to embank and reclaim them, but all of which ended in failure, until in 1634, William, Earl of Bedford, undertook to drain them on the understanding that 95,000 acres of the reclaimed land were to become his. For three years he prosecuted his labours, expending in the attempt £100,000, but again failure was the result. In 1649, the Earl, nothing daunted, again commenced operations, and after outlaying £300,000 in draining, embanking, and protecting the land, met this time with success. In 1664 a corporate body was formed for the management of the reclaimed lands,

which is still in existence. The Fen lands are intersected by numerous channels, some of them being navigable for over twenty miles. In draining the marsh, the water was raised by wind-engines. In some cases these engines turn a perpetual screw, fitting into a semicircular trough, inclined at an angle of about 30° , the lower part dipping into the water below, and discharging by its revolution the water into the higher level. By this form of engine the friction of pumps and wearing out of machinery are reduced to a minimum, and the mills require little attendance, but work night and day as the wind blows. I have heard high praise of this form of engine from natives of Schleswig Holstein, where it is in constant use, and it was used with great effect in emptying the dry docks at Shanghai. The Dutch, who carry on this system of drainage extensively in their lowlands, employ scoop-wheels worked by wind-engines; and where the lift of water is not more than seven feet, they are very effective.

Where the drainage falls into a tidal stream or creek, and the point of outfall is below highwater marks, the action becomes intermittent,—that is to say, the drainage water can only pass into the stream at those periods of the ebb and flood when the water-level of the stream is below the level of the sill of the outfall, or at least sufficiently low to be overcome by the head of water in the drain, and sluice-gates or tide valves are necessary to prevent the tide water from entering the drain. The sluices will open to discharge drainage when the ebb-tide has fallen sufficiently to reduce the outside pressure below that exerted by the water in the drain, and will remain open until the in-coming flood has again risen to the same point, when they will be closed

by the pressure of the tide. Where the water in the drain is much higher than the flood-level outside, a considerable portion may be discharged through a valve in the upper part of the sluice or by side valves in the masonry; and as soon as the water outside has fallen so far that the head of water inside can overcome the friction of the hinge and the outside pressure, it will begin to discharge, although the tide may still be above the level of the sill or floor.

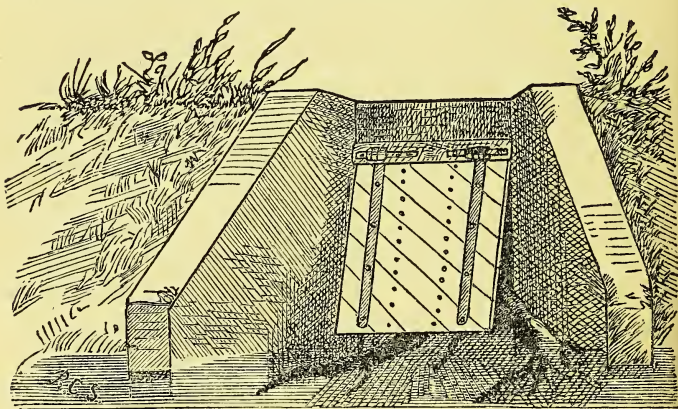
No matter of what construction, or however well-constructed and well fitted sluice-gates may be, there is always some weak point about them, some liability to accident or derangement, which renders them a source of constant anxiety and necessitates constant attention. If the material be iron, it corrodes; if wood, it swells or shrinks, and rots under the influence of alternate wetting and drying.

If self-acting, they get jammed and choked with floating rubbish, grass, trees, &c. If worked by hand, they are liable to neglect by watchers, who forget to open or close them at proper times.

Where drainage outfalls pass through or communicate with rice-fields, they require, whether self-acting or not, careful watching, as in dry seasons the raiyats will force them open to admit the river water to irrigate their fields. I have in my mind, whilst writing this, two large and important so-called self-acting sluice gates communicating with the river Hooghly, which are a source of constant trouble, and which have never been anything else during my many years' acquaintance with them.

One is an upright gate or tide-valve hung by hinges at the top, and abutting perpendicularly against masonry

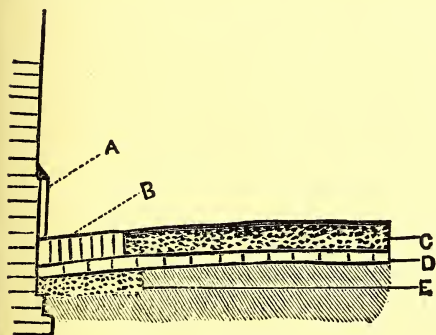
walls, as shown in figure. It is constructed of wood, covered with sheathing metal, and with long strap hinges. It is constantly obstructed in the manner depicted, and is thus effectually prevented from closing when the tide rises, which consequently floods the drain and heads back the sewage water of the town.



The main faults of this sluice are its unwieldiness, and from its being hung perpendicularly, it is not properly self-closing until forced back by the tide water. A lighter gate with slightly sloping abutments would be better, as it would shut close with its own weight, be kept close by the pressure of the water outside, and would yield easier to the pressure of the inside water as the tide falls.

With proper supervision, the draw-up sluice or penstock worked by hand, is the better form. It can be worked by one man, and can always be constructed to fit better and be more water-tight than any self-acting sluice; and as there must necessarily be a man always in charge of it, it is less liable to be obstructed by drift.

Where funds permit, all surface drains within towns and along the streets should be made pukka. There are several forms of surface drains, the neatest and most efficient for drains of small width, being made of artificial stone moulded to the required section. Other useful forms are tile and brick-on-edge drains. Bricks for drain floors should never be laid *flat*, and all the joints should be raked out and cemented. Where streets and lanes within towns are very narrow, so as not to permit of drains being excavated or constructed on both sides, the free passage of the surface water may be provided for in the manner shown in the section in the margins, the surface of the lane being sloped towards the side, a half drain is formed by laying brick on edge over the soling brick, which should be lifted and replaced over nine inches of concrete as shown in the margin, the basement of the house walls being plastered with Portland cement to a height of one



foot. The advantage of this form is, that, while it provides free passage of water, it does not reduce the width of the roadway, as carriage wheels can pass over the drain without injury to either.

All covered drains and under-ground sewers are a mistake, unless there is a constant and sufficient flow of water to flush them.

CHAPTER XII.

“Before erecting statues, building museums, and buying expensive pictures, towns should be relieved of bad odours and fermenting putrescence. Good privies are far higher signs of civilization than grand palaces and museums of art.”—*Stramm*.

There is no branch of practical sanitation more important, or which has given rise of late years to so much discussion amongst sanitarians and municipal authorities, as that which deals with the removal of excreta from dwellings and towns, and with its ultimate destination, whether as regards its economic utilization or simply as regards its disposal in such a manner as to secure it from being any longer a nuisance or a danger to the health of the people; and the subject is one which, far from having arrived at a satisfactory settlement, is daily forcing itself more and more on the attention of all connected with, or interested in, the health of towns, the preservation of watercourses from pollution, and the increase of the reproductive powers of the soil. In thinly populated rural tracts, the subject is of little importance, for that, first of all deodorizers, the earth, receives and assimilates the thinly scattered excretal deposits; and owing to the desiccating power of the sun,

the rapid diffusion of effluvia through the air, and the absorption of the liquid and organic matter by the earth, there is little nuisance or danger resulting. "It is only when men collect in communities that the disposal of excreta becomes a matter literally of life and death, and before it can be settled, the utmost skill and energy of a people may be taxed."—*Parkes*. So far as theory is concerned, we may, without hesitation, accept the views propounded by the advocates of utilization of all excremental matters in enriching and recuperating exhausted soils, and thereby multiplying their productive powers; for the agricultural value of sewage constituents has been abundantly proved by repeated trials and practical operations extended over a series of years and in various countries and climates, from China and Japan to the farms of the North American Union. But putting aside general sewage systems,—that is to say, removal of town sewage by water carriage through a complete system of underground sewers and drains,—there is no known system of disposing of the fæcal matter of large towns which can yet be called an economical or commercial success. Professor Corfield justly says, that "No scheme which does not remove *all* refuse matter in as inoffensive a manner as possible, and utilize it so as to 'make it pay,' can be accepted as anything like a final solution of the question that we have to study, nor can such a scheme be recommended to towns as a feasible plan for the removal of their difficulties."

The Executive Committee of the Society of Arts, at a conference held in 1876 on the health and sewage of towns, came to the following conclusions:—"That with regard to the various dry systems, where collection at

short intervals is properly carried out, the result appears to be satisfactory, but no profitable application of any one of them appears as yet to have been accomplished ;” and further, that, “as a rule, no profit can be derived from sewage utilization.”

Putting aside then, for the present, the economical and commercial view of the question, we will revert to what is, or should be, the primary object of the local sanitary authority,—*viz.*, to secure the removal regularly, rapidly, and thoroughly, of all excreta from dwellings and public latrines ; the absolute necessity of our doing so will not be disputed by any reasonable being. The evil effects of allowing fæcal deposits to remain and decompose within, or adjacent to, dwellings, has already been touched upon in the earlier chapters of this book, and it is, therefore, unnecessary to do more than allude to them here ; but we cannot too often repeat that this is a duty which must be carried out at any cost. “Safety,” says Dr. Parkes, “is the first thing to be sought, profit must come afterwards.”

“For health’s sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost.”—*Confer., Society of Arts.*

I think few people will be found to dispute this doctrine, and no argument is necessary to satisfy any person that accumulations of filth cannot be left in human dwellings without danger to life and health, and violence to all sense of decency and cleanliness.

Some persons may argue that such accumulations do remain, and have remained, for years in well-privies without causing any visible harm ; that there are in many native dwelling-houses *Sundeskes*, which have existed

for many years without the inhabitants of those houses suffering from their evil effects. I admit the first part of the proposition, but I have never found proof of the latter; and I beg leave to doubt it as opposed to evidence, science, and common sense. I admit that these abominations are by no means peculiar to this country, that, in England, Scotland, the Continental Cities and in New York, there are privies and cesspools to the full as bad or even worse than those in existence here; but the evil of them is fully recognised, and if they are evils and dangers in temperate climates, what must they be in the warm, moist, tropical atmosphere of Lower Bengal. There is perhaps no subject on which the middle class residents of our native towns are more averse to any change than in the regulation and improvement of their privy accommodation, and herein they lack not only one of the most important comforts and decencies of life, but many of them do not even know that they lack it.

With bodies that are susceptible to the poisonous influences of putrefying filth, with their health more or less constantly subject to these influences, undeterred by the warning given by the loss of relatives who have fallen victims to malarious or filth diseases, they live on, indifferent to, if not ignorant of, the dangers and discomforts that surround them. They are busy in accumulating the means for more luxury, while they remain blind to improvements that, costing but little, would prolong their lives, secure exemption from disease, and make their homes much more fit abodes for an intelligent and prosperous people.

I feel sure that in no other direction could compulsory measures be applied with greater justice and pro-

priety than in compelling the removal of human excreta from amongst the dwellings of the people, and if then we recognise the general principle, we must further recognise the principle that such removal must be effected, irrespective of cost, and that that cost, whatever it be, must be borne by the community. We have, therefore, to consider how such removal is to be effected in as efficient, while in as economical, a manner as possible, and in so doing we may at once put out of the question, as beyond the scope of most small mofussil towns and villages the system of water-carriage.

That system involves an enormous expenditure, and requires the existence of three main features,—*viz.*, a complete system of underground sewers, a sufficient and efficient watersupply, and a convenient and unobjectionable outfall for the contents of the sewers. Where *all* these conditions do not exist, and they form a *Sanitary Trinity*, neither of which can work without the other, the hand-system, or removal in substance, must be adopted, and it is with the hand-system in its various forms that I purpose to deal.

The following are the most usual methods of removal by hand in use either in England or this country :—

The dry-earth, or Moule's system,

The bucket, or Hallalcore system.

The pail-system, of which there are several varieties,—*viz.*, 1st, pails or tubs in which a certain amount of a deodorant or disinfectant is used, as in Rochdale, Nottingham, Leeds, &c.; 2nd, pails used without any preparation, as in Glasgow, Berlin, Leipsic; 3rd, pails into which coal ashes are sifted over the excrement (Manchester, &c.); 4th, pails into which ashes and general house

refuse are thrown, as in Edinburgh; and 5th, pails lined with an absorbent material (*Système Goux*), as in Halifax, Salford, and some continental cities.

Of all these systems the one which has, rightly or wrongly, had the greatest number of advocates, is the dry-earth, or *Moule's system*, and it is perhaps none the less creditable to its reverend adaptor, in that, though certainly in regard to its essential principle not his own invention, he may claim the credit of practically proving the sanitary wisdom of the great Hebrew lawgiver, who laid down this law to the children of Israel.

“And thou shalt have a place also without the camp, whither thou shalt go forth abroad; and thou shalt have a paddle upon thy weapon, and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith and shalt turn back and cover that which cometh from thee.” It is hardly necessary to say that the first principle of this system is that dry-earth is the natural deodorizer of excremental matter. A given quantity of dry earth destroying all ill-odour, and entirely preventing the escape of noxious vapours. It is claimed for this process that the addition of from one and-a-half to two and-a-half pounds of dry earth to each stool is sufficient to render it inoffensive; that a certain disintegration of the fæcal matters, and combination between the earth and the organic matter contained in the excrement takes place; and that, after a short time, everything offensive disappears. That this system possesses all the advantages which its advocates claim for it there can be no doubt, and for jails, hospitals, military barracks, or similar institutions, where the number of persons is comparatively limited, labor abundant, and scientific supervision always avail-

able, it is in every way admirable and desirable; but for a large town I have no hesitation in saying, and in this I am supported by good authorities, that it is simply impracticable.

For every pound weight of excreta to be carried out of the town, three to four times the amount of earth must be carried in, to be carried out again.

Then we have to consider the difficulties of procuring, drying, storing, and distributing the earth. We have the well-considered testimony of the River Pollution Commissioners, that "they have no hesitation in pronouncing the dry-earth system, however suitable for institutions, villages, and camps, where personal or official regulation can be enforced, entirely unfitted to the circumstances of large towns." It will be obvious also to every one who thinks over the subject, that the system, depending as it does, on the *dryness* of the earth to be used, could never be introduced with success in any town subject to from four to five months' constant and heavy periodical rains. We may, therefore, dismiss this system as impracticable for general municipal purposes, in spite of the constant, though somewhat inconsequential, advocacy of its admirers. The author was the first to introduce (in 1874) on this side of India what is called the Bombay Hallalcore system in a somewhat improved form, and this was subsequently followed by its adoption by the Calcutta Municipality and other Corporations. The system may shortly be explained as the employment by the municipal or local authority of a regularly organized corps of scavengers or nightmen, and the division of the houses in the town into blocks or circles. The houses are allotted to the nightmen, in the ratio of about thirty

houses per man ; these visit each house daily (in the early morning), and remove the contents of the privy-pans in a closed wooden or zinc bucket (in Bombay at the time of my visit open baskets were in use !) to central depôts, where the filth is either collected in airtight iron-carts to be removed beyond the town, or is discharged directly into basins connected with the sewerage, where such exists. The system, when well worked and properly superintended, is one of the best hitherto tried in this country ; its primary feature being the regular daily removal of the filth.

The Sanitary Commissioner for Bengal, after inspecting its working in the suburbs of Calcutta, recently reported upon it in the following terms : “ On the whole the system is an admirable one, when well looked after, and worthy of imitation in other municipalities.” But although the working has been very successful, and has effected undoubted improvement in the sanitary condition of those towns where it has been introduced, it has many and serious drawbacks and failings, nearly all of which might be obviated by the adoption of one of the pail-systems before alluded to. The chief objections to it are, that it is an expensive system requiring a very large staff.

It is from its great extent and the number of men employed difficult to supervise and control ; no efficient check can be employed over the nightmen without the entertainment of an enormous inspecting staff, and, therefore, neglect to remove the filth is a common occurrence.*

* This difficulty may be obviated by giving the work to a contractor, an arrangement recently adopted by the Calcutta Suburban Municipality.

It is a filthy system in practice, and gives rise to domestic and public nuisance of no slight character. The system of working is as follows:—The scavenger goes from house to house with a bucket and broom; into the first, by the aid of the latter, he empties the contents of the privy-pan, generally a wide, shallow earthenware pan, but often he leaves the bucket open by the roadside, while he goes up a narrow alley to the privy and brings out the filth in an earthen pot to be emptied into his bucket in the street. Can any greater nuisance to the early pedestrian be conceived? The nuisance within the privy is even greater, the porous earthenware vessel roughly emptied of its contents, presents an increased foul surface to give forth effluvia.

Professor Corfield notices this very point with regard to similar systems at home. He says: "The removal of the matter is at all times a filthy operation, and the iron-pans when empty smell even worse than when full, as there is then a greater surface exposed." Then it is almost impossible to check the practice of the scavengers placing their tubs, full or empty, on the roadsides while they enter the houses, or go to smoke or rest, and being, like all persons of that class, careless in the extreme, the lids are continually lost and the contents exposed. The sights and smells, which those who indulge in early morning rides and walks about an Indian town are exposed to, may be better imagined than described.

The advantages of a weekly pail-system are obvious; the first factor is the pail or tub. This may be either of metal or of wood; in shape it should be round and straight, but slightly wider at the bottom than at the

mouth to insure strength ; of sufficient capacity to contain the faecal matter of a house-privy for a certain given time ; and it must be fitted with handles for removal and a tight-fitting lid. A pail, eighteen inches high by fifteen inches diameter, will contain the dejecta of sixty persons for one day, or six persons for ten days' use. The pail is placed directly beneath the privy seat, and left there undisturbed for the number of days fixed for the rotation. When removed, it is covered with the lid, carried to a covered cart, and a clean pail left in its stead. By this means there is no disturbance of the filth, and consequently less chance of disengagement of gases and effluvia.

Another advantage is, that the tubs being taken direct to the place of discharge, a thorough check is practicable, as the person in charge will at once detect and report any defaulting scavengers who fail to bring their due tale of tubs. The following information regarding the working of the absorbent pail system (*Système Goux*) is taken from details kindly supplied me by the Chairman of the Sanitary Committee of Halifax, where the *Système Goux* has been in use for ten years. I would not, however, presume to offer my readers simple extracts from the records of other towns, had I not personally and practically proved by experiment that the system is workable in this country ; but after fairly testing the principle I have no hesitation in pronouncing it to be in every way satisfactory and practicable, easy of management, economical in working, and—what is an element not to be overlooked by those who have the management and control of that somewhat difficult and obstinate class, the *Helas* and *Haris*

(the nightmen of Bengal)—in no way opposed to their prejudices:—

“In reply to your inquiry of the 24th March respecting the pail-system as adopted here, I have pleasure in sending by this post the Journal of the Society of Arts for June, 1877, wherein you will find a report by me as to the working of the Goux system. Since that time we have continued to supplement the old and detestable privies and middens with these, and every one is satisfied that we have got the best method yet introduced for the removal of excreta and house refuse. The present cost per closet per annum is about 15s., and we empty them once every eight or ten days. I may say that a bottomless can or shell is first put into the closet tub with a space left of about three inches between the can and tub; this space is filled with absorbent material: many things will answer for the purpose of packing or lining the tubs, Here we get a good quantity of woollen and cotton dust and refuse from the mills, which is of itself a good manure. We also use dry street sweepings, screened ashes, &c., but the latter requires some fibrous substance mixing with it to make it stand round the tub after the can or shell is taken away, which is done when the closet tub is left at the closet; the cans are then put under the van, and the tub inside the van and driven to our dépôt. When the full tub is taken out of the closet, a handful of the packing is taken out of the new tub and sprinkled on the full one, and the public can then see nothing but what appears a tubful of mill refuse or other material.

“Of course, in Calcutta you will have material suitable for lining the tubs, but I cannot suggest what would be best. We get a material, if we can, that makes a good

manure independent of the excreta, otherwise we might get packing of less cost and so reduce the cost of collection.

"I think the members representing this Borough in Parliament will bear me out in saying there is no method yet introduced to supersede ours. . . .

"At the commencement we found some difficulty in having to number each closet door for the guidance of the men and in finding customers for the manure; but now we have it in such working order that there is little or no trouble, and very few complaints, and only those where the collectors are now and then negligent. The tubs we use here we make from petroleum or paraffin oil barrels or fruit barrels; the former are more serviceable and cost less; they are cut in two for closet tubs. . . .

"I must confess that, in my opinion, and in the opinion of the Sanitary Committee over which I have the honor to preside, the Goux principle is the most satisfactory we have yet seen, and we have seen many, and have given the subject some consideration during the last seven years. The great advantage over others is, that the packing which is placed in each tub will absorb from six to eight quarts of liquid, and the charcoal or soot which is in the packing prevents decomposition, and deodorizes the excrement and urine as the tub becomes full; and also to a great extent fixes the ammonia, and so makes a good fertilizing manure. We have tried the plan without lining, and found the disinfectant, which was put into the bottom, was soon so much diluted that, to a great extent, it lost its effect as a deodorizer and disinfectant; and when the receptacle was used partly full, there was a disagreeable effluvia on account of its

being nearly in a liquid state, whereas the liquid or urine is gradually absorbed and deodorized by the packing of the Goux tub. Another advantage of the system is, that when the sanitary inspector informs the manager of the Goux department of any case of fever, the closet is cleared every two or three days; and, from an analysis which has been made, it was found that there had been fewer cases of fever in the wards or districts where the tubs were in use. I am satisfied that constant removal is a step in the right direction, and am glad the question is receiving more attention than it has hitherto done, for we ought no longer to allow fæcal matter to be deposited within a few feet of the very atmosphere we breathe, and allow it, together with all kinds of animal and vegetable matter, to decompose for twelve months, and in many cases the liquid matter to percolate under our house floors.

“There were more cases of fever where the old privy system prevailed than where the Goux closets were in use.

At a meeting of the Conference of the Society of Arts, the system in force in Halifax was very fully discussed, and the following interesting and valuable testimony was given in favor of the *Système Goux*:—

“Mr. Denham (Southsea) asked whether the process was very offensive one to look at?

“Mr. Pollard thought not so offensive as the system without the lining, or the old privy system.

“Dr. Syson said he had had experience of the Goux system in its earliest introduction, and had been asked to give his opinion upon its merits. He saw it first about 1869, when he was connected with Salford, and

they were making sanitary experiments with a view to abolish the old middens. The simplicity and cleanliness of this system then struck him. He called the attention of the Health Committee to it, and a somewhat extensive trial was made. During the time it was on trial they had an outbreak of smallpox, but in the district where it was in use, the lowest in the town, not a single case occurred. It had been said that it was abandoned in Salford as a failure, but this was an utter mistake. It was not given up because it failed, for they had numerous deputations from various Health Committees to inspect it, and all gave their opinion unanimously in its favour. He believed the real reason it was not adopted generally was, that the scavenging was not in the hands of the Health Committee, and that the Scavenging Committee were, as often happened, too much wedded to old customs. It might be said that he was an officer of health, and that officers of health might not be quite unbiased, but you could not persuade numerous deputations consisting of town councillors and aldermen in that way; and it was on record in the minutes of their meetings repeatedly, that they thought this system a great improvement on the old system. He was not an opponent of water-closets, and for a single house no doubt the earth-closet is preferable, but for towns or villages where water-closets could not be well introduced, this system would be much preferable.

“Dr. Haviland, being medical officer of health to the Northamptonshire combination, which included not only that county, but also portions of Leicestershire and Bucks, found, some four years ago, when he first entered

on his duties, that the sewage disposal was the great difficulty he had to contend with, and, practically, in the 365 villages and towns under his charge, the water-carriage system was a failure. On setting to work to see what could be done to meet the difficulty, he found that the first thing to do was to see that a proper system of scavenging was carried out. Next year he examined the different modes of sewage disposal which had been proposed by different companies, and carried into execution throughout the country; and, after finding failure here and failure there, he was much struck with the success of the dry mode adopted at Aldershot. He thereupon went into it more thoroughly, and promised to lay a report before the sanitary authority; and for this purpose he went again to Aldershot, and twice to Halifax. In order to see the real effect upon the public health of this system, he determined to investigate the whole matter for a great number of years, in order to show the geographical distribution of disease. He first required to satisfy himself that the health of Halifax had really improved since the adoption of the system under investigation. He found that, in 1870 to 1872, before the practical working of the Goux system had been adopted, the mortality from all causes was considerably greater in all the different districts than it was later. He had very carefully worked out these figures himself for every case of death for the last ten or fifteen years, and had eliminated all doubtful cases. To show the Northamptonshire combination of sanitary authorities his belief in the efficacy of the Goux system, he undertook this laborious task, and also to satisfy his own mind, because without doing so he could not recommend such

a large area to adopt any system. Since then he had been pleased to see the result of this dry system, and was still recommending it. Only yesterday, in Leicestershire, where he was sent for suddenly in order to meet the defects of the sewage system in a village, he found the only thing he could do to avert an impending outbreak of typhoid fever was to send at once for a number of these tubs, to replace the system which was really producing the fever, and until he saw a better plan he should continue to recommend this system. He had no interest either in this company or any other, but he simply wanted to see carried out a better system of periodical scavenging, and to see the sewage not taken to the soil before it had time to become so matured as to be of any material benefit to the land. . . .

“Dr. Haviland replied in the affirmative to another question, whether he attributed any special virtue to the Goux principle beyond its being a dry system of removal. He said, what he had found in practice was this, that the principle of the dry system was good, but the mode in which it was carried out was sometimes offensive. Moule's earth-closets were very excellent in principle, but he found in practice their having complicated machinery rendered them useless in villages. Wherever there was anything like complication, there was sure to be failure. The simpler the article you provided the better.

“The Chairman asked if he considered the particular kind of lining used to be advantageous?

“Dr. Haviland said, almost any refuse sufficiently absorbent would answer the purpose. At Northampton, and in villages near, they were going to use tan, and in

other places stable litter would do. In the huts which were run up for the accommodation of the workmen engaged on railway works in his district, he recommended them, as horse-power was used to a great extent to line the Goux tubs with stable litter. In Halifax shoddy was used; but anything which would absorb well and form a casing would answer the purpose.

“ Mr. Moore said, that some twelve months ago he had to advise the authorities of a town of about 2,000 inhabitants what they should do with their drainage, there being much illness from defective sanitary arrangements, and the Local Government Board compelled them to do something. He came to the conclusion that a dry system of some kind was better adapted to their circumstances than a drainage system, and it was also a known fact that the germs of typhoid fever existed in the discharge from the bowels, and that if you could keep these out of the sewers you would eliminate that factor of disease which was most active. He did not oppose the water-carriage system entirely, because it was working very well in large towns, specially in London, and though it occasionally gave rise to evils, it did not do so to any great extent, and those who had already provided sewers should not attempt to abolish them, but to render them perfect. Where, however, sewers did not exist, it was a different matter. His first idea was that earth-closets would be best, and in many places they acted admirably; but never, he believed, in a place of 2,000 inhabitants would it be possible, especially in a wet season, to get enough dry earth to work them. Finally, he recommended the use of tubs, as employed at Roch-

dale, with disinfectants in them ; but a week after sending in his report, seeing a paper by Dr. Haviland on this very subject, in which he spoke of what appeared to be the marvellous result on the health of Halifax from the adoption of the Goux system—and he should recommend any one interested in the question to read this paper—he determined to look further into it. He next saw a report by the Goux Company, in which the opinions of several medical men were brought forward, giving their experience in favor of the Goux closets, especially at Aldershot, and he, therefore, determined to inspect it for himself. It was stated in the report that there was then a heap of manure of about 40 tons giving off no smell at all, and he, therefore, accompanied by the Inspector of Nuisances and a large builder in the town, went over to examine into it. The Inspector of Nuisances rather laughed at the idea of the pail-system, and the builder was opposed to it, because he thought he might probably have the contract to drain the town. They went all round the place, and visited nearly every closet in the north camp, and though it was a very wet day in November, they did not find what could be called a nasty smell in any one, and, in the great majority, if they had been taken in blindfold, they would never have thought that they were in a place of the kind at all. Those who accompanied him were of the same opinion, and the builder entirely gave up his opposition, and had adopted one of these closets in his own workshop, and consoled himself with the idea that instead of getting £500 out of the drainage he might get £200 out of the Goux closets. When at Aldershot he asked an old soldier, whom he saw

coming out of one of these places, if there was ever any smell in the summer, and he replied that there was sometimes a little, but not half so much as in 'them stinking water-closets in the south camp.' He was not satisfied with this, but went to Halstead, in Essex, a small town where there had been an injunction against turning sewage into the river, and which had adopted the Goux closets. He was informed by the Surveyor that there were 170 at work, and that there were no complaints whatever. Since then he had received a letter from the Medical Officer of Health giving the same testimony, though he said he liked the water-closets best, because they were less trouble. He was informed that the tubs were lined with a mixture of horse-droppings collected from the streets and sifted ashes, and he found the places where this was prepared smelt much like a stable, but nothing more. He went into about 50 of the closets, some new and some old, and in only one or two instances was there anything like a smell, and that was where the tubs had been allowed to overflow. They were collected about once or twice a week by men in a waggon; no annoyance was caused."

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CHAPTER XIII.

“ Now there was beneath the Altar of Solomon’s Temple a certain cave, whereby the filth and uncleanness were carried down into the valley of Kedron, and the gardeners paid so much money as would purchase a trespass offering for fertilizing their gardens therewith.”—*Mishna. Jewish Tradition.*

Having considered the mode of collection and house-to-house removal of nightsoil, we have now to consider how it is to be disposed of, whether by conversion into poudrette, or some other form of dry manure; by direct application to the soil as a stimulant to cultivation, or simply by burying it, so as to dispose of it with the least trouble and expense.

Years ago attempts were made by a gentleman (Gilbert Hickey, C.E.), since deceased, to utilize nightsoil by converting it into gas for illuminating purposes, the dry residue being a perfectly harmless inodorous poudrette. These experiments were conducted at the Alipore Jail, and, apparently, with great success; but from want of capital or means to push the invention, the experiments never went beyond that stage, and the inventor shortly after died, leaving his experiments incomplete. I need not do more than allude to the elaborate systems in use in Birmingham and other large towns in England, where the filth is converted into valuable manure or into Port-

land cement by the aid of extensive and expensive machinery ; but I may shortly notice what is known as the Rochdale system, as it has, with certain modifications, been already adopted by the municipal authorities of some Indian towns, notably Poonah, in the Bombay Presidency.

The Rochdale system is thus carried out:—"The ashes collected from the houses are carried out to the manure depôt, and are there screened by machinery. The fine ashes are then spread out in deep layers and into a series of trenches made in these layers, the contents of the excrement pails are emptied and covered with fine ashes. Sulphuric acid is then added in the proportion of 25lbs to one ton of the excrement to facilitate drying. The proportion of fine ashes to excrement is thirty-five of the former to eighty of the latter." This process, however, is said to have been so expensive that, latterly, the pail contents were merely mixed with the house refuse and ashes, and great difficulty is said to be experienced in getting rid of the mixture, which is pronounced to be most offensive.

The Poonah system is called by the local authority the 'sun-drying process,' and is thus carried out:—"The street and house refuse collected from the dust-bins of the city are carted out and burnt into ashes. Beds are formed with floor made of *murum* or other hard substance to receive the nightsoil. The beds are eighteen feet square and one foot deep. A layer of ashes one inch thick is first spread over the floor of the beds, and nightsoil is then poured on about five inches deep, and is covered over with another layer of ashes also one inch thick. It is then allowed to remain for twenty-

four hours in the sun, during the fair season, and for three days under sheds, during the rainy season. The nightsoil is, after the lapse of the time mentioned above, stirred and well mixed with the ashes spread above and below it, and a fresh layer of the latter, half an inch thick, put on, when it is allowed to lie for three days further in the fair season, and eight days during the rains. The mixture is then again stirred, taken out of the beds and spread on dry open ground exposed to the sun, to complete its drying. It is then stored in heaps for sale, and is in dry weather fit for immediate use. In the rainy season the drying has occasionally to be done under cover, and, consequently, the process occupies as many as twelve days, whereas in the cold season it takes six, and in the hot season only four days.

It is said that the manure thus prepared is so much appreciated by cultivators that payment is frequently made four to six months in advance to secure a supply.

The financial result is certainly encouraging, the total cost having been Rs. 18,000, and the receipts Rs. 5,000, per annum. The actual cost of removing the filth from the town, an unavoidable charge it must be borne in mind, was Rs. 14,400. So that the net profit, on the actual expense of manufacture, *viz.*, Rs. 3,600, was Rs. 1,400, or nearly 39 per cent.

Of the various modes of applying the excreta directly to the soil, we may first consider the system which has been adopted by the Calcutta Suburban Municipality, not because it is by any means a complete or thoroughly satisfactory system, but because it fulfils the first great necessity, and overcomes what is always the first great difficulty, in introducing any system of scavenger-

ing into an Indian town, whilst it also possesses other undoubted advantages, and is, I may say, the first practical step towards the utilization problem.

The system is the burial of the nightsoil in trenches in garden grounds, as far removed as conveniently may be from human habitations, and the subsequent cultivation of the ground so used. It differs from the Bengal Jail system mainly in the size and depth of the trenches, the municipality being compelled from the difficulty of obtaining suitable lands within a reasonable distance of the town to make the trenches as deep as possible to economize space. That this is a weakness in the system I unhesitatingly admit, but it cannot at present be avoided, and that the evil is not so great as some sanitarians argue, will, I think, be proved by the following result of the operations.

A series of examinations were made by me from time to time to test the deodorizing and decomposing power of the soil, with the following satisfactory results :—

1st.—Ground used for the burial of nightsoil in the month of April, was opened up in the beginning of November following. To a depth of two feet from the surface the soil was ordinary, stiff alluvial earth; the next or nightsoil layer, consisted of a loose rich, black mould, without any offensive smell or any trace of faecal matter, quite fit for garden purposes. After a few days' exposure to light and air, it was undistinguishable from the surface soil.

2nd.—Trenches used in all May were dug up, the nightsoil layer being a bluish black mould, free from any smell or appearance of faecal matter.

3rd.—Trenches used in June and July were not sen-

sibly different from the last, except that traces of faecal matter, chiefly fibrous, were visible throughout the mass.

4th.—Trenches used in August were somewhat offensive when opened, and faecal matter was found in masses still unconverted.

5th.—The trenches recently filled in November were perfectly inoffensive, until the layer of nightsoil was exposed by the spade, when an offensive odour was perceptible close to the trench. But the mass was perceptibly undergoing a change.

I may remark that every effort is made to mix the soil with earth as dry as possible when the trenches are being filled, and that the last eighteen inches is filled up with earth alone.

The advantages gained, therefore, are, that the filth is effectually disposed of without causing nuisance; the lands employed are gradually raised—a great consideration in a low-lying locality, and their productive powers are enormously increased. I do not overlook the fact that sanitary authorities in India have, to a certain extent, condemned the practice of burying nightsoil; and I find that the Army Sanitary Commission (1869), remarked,—“that the practice of burying the mixture of earth and excrement must result in fouling large areas of ground,” for that, “even after careful mixture of excreta with earth, the mass, when buried, gives out offensive vapours in damp or rainy weather.” They also say: “It still may be taken as showing that, in India, the earth process and subsequent burial are inadequate for the requirements of health, at least in the case of large fixed populations; and *that if this process is to be continued for such populations, it must be modified,*

and brought more in accordance with natural laws." This is, it appears to me, the pith of the whole argument, the necessity of 'bringing it more into accordance with natural laws.' And this is only to be done by cultivation, and applying the excreta to the soil in the manner most convenient for its rapid absorption and assimilation by growing vegetation. "It is only the action of the living and growing vegetable which recomposes the products of decomposition and carries out to its consummation the process of disinfection, even as it is only through plant-life that we can reach the goal of utilization." The roots of plants are actively and unceasingly at work absorbing the products of decomposition as they are evolved, and thus preventing their escape to the surface.

At the commencement of the working the owners of the lands who had, after considerable persuasion, leased them out to the Municipality, complained that the standing fruit-trees were being injured by the burial of soil close to their roots; but, on careful investigation, these apprehensions were found to be groundless. The only instances where the trees had really suffered were distinctly traceable to the excessive cutting of their roots in digging deep trenches alongside of them. On the contrary, they largely benefited as a rule, and in many cases old trees recovered, put out new flushes of leaf, and began to fruit, though previously barren.

After the trenches have been filled, closed, and the ground has settled a little, it is dug over regularly and cultivated with jute, sugarcane, fodder, maize, guinea grass, reana luxurians, or lucerne. Carrots have also been found a useful crop for horse-fodder, but, as a rule, *root*

crops are not suitable for first cropping on such richly manured lands. Jute and coarse strong feeding grasses are better for the first crop. Jute, which seldom attains a great height in this part of Bengal, reaches twelve and-a-half to thirteen feet, and is proportionately stout, with good, fine fibre, fit for the manufacture of Hessian cloths. Sugarcane yields a fair heavy crop, and all the grasses are entirely successful.

The following will be found a convenient rotation for working nightsoil grounds over a series of years, the main principles to be observed being—

1st.—The occupation of the land for a sufficient time for trenching in the filth.

2nd.—The planting of such crops as are strong coarse feeders, and which consequently exhaust the richness of the soil, followed by those less exhausting.

3rd.—The regular succession of perpendicular rooting and horizontal rooting crops.

4th.—Not repeating the same crop in the same ground.

5th.—Regular periodical retrenching.

ROTATION.

From 1st Feby. to 31st May,	4 months,	Trenching.
„ 1st June to 31st August,	3 „	Fodder maize.
„ 1st Sept. to 30th Nov.,	3 „	Country carrots.
„ 1st Decr. to 31st March,	4 „	Trenching.
„ 1st April to 31st May,	2 „	Fallowing.
„ 1st June to 30th Sept.,	4 „	Jute.
„ 1st Oct. to 31st January,	4 „	English carrots.

Another plot of ground would be trenched alternately with the last, thus—

From 1st June to 30th November, 6 months, Trenching.

„ 1st Decr. to 31st May, 6 „ Guinea grass.

And another portion, as follows:—

From 1st Feby. to 31st May,	4 months,	Trenching.
„ 1st June to 30th April, 11	„	Sugarcane.
„ 1st May to 31st August, 4	„	Trenching.
„ 1st Sept. to 31st January, 5	„	Carrots (English).

Of course these dates cannot always be strictly adhered to, but must vary according to the earliness or lateness of the seasons in different parts of the country.

Where the local markets are badly supplied with English and country vegetables, they may be grown with the greatest success on ground thus manured, and are far superior both in size and quality to the ordinary garden vegetable.

The late Dr. Fawcus, Superintendent of the Alipore Central Jail, who took great interest in this subject, advocated the cultivation of plantains, and was of opinion that a square mile of ground so cultivated would yield an annual income of Rs. 300,000. I extract the following from a memorandum on the subject:

“The cultivation of bananas requires little or no knowledge of farming, and very little labor or care. All that has to be done is to plant in rows, and manure well the interspaces. I know from experience that human excrement is especially suited to plantains, and that, when well manured with this, they yield enormous crops, and do not require the usual triennial transplanting.”

The principal objection to this form of cultivation is the long time that the ground is occupied by the plants. Where ground is plentiful and need not be used oftener than once in three years, plantain or banana cultivation would be undoubtedly profitable.

The following testimony as to the value of nightsoil.

earth is given by an experienced horticulturist, Mr. Superintendent Lynam, of the Calcutta Police :

“I now give you my promised report on the night-soil earth. I must say that, as far as I have experimented, it has been a great success. I have tried it on more than two hundred rose plants, and on every plant there was a marked improvement both in vigorous growth and profusion of flowers; and moreover, there is a second set of flowerbuds forming after the first set was cut away. This I never had before. What pleases me with it most is, that it is not a heating fertilizer, and therefore does not unduly stimulate the plants. It is certain to improve roses in bad health, and I must say that a very valuable manure has been wasted up to the present time. It would be admirable for tea plants: it should not be put directly to the roots, but the surface soil should be loosened, the earth mixed with it and watered copiously a day or two after. I may remark that, after exposure to the air for a short time, it loses all its offensive qualities, and a *mali* may handle it without knowing it to be other than ordinary soil.”

The next question for our consideration is, whether the collection and utilization of the filth of a town can be made to pay the cost of cleansing and removal, or yield any substantial return to the town for the outlay incurred; and this is one which cannot, I fear, be satisfactorily answered so far as Bengal is concerned, despite English or Continental precedents and the theoretical calculations so confidently put forward by Mr. Buck, the Director of Agriculture and Commerce, N. W. P., and even of the actual experiences of the few Indian towns that have succeeded to some extent in profitably disposing of their filth.

Before we can confidently look to the utilization of excreta as manure in a profitable sense, we must expect a total alteration in the feelings, habits, and prejudices of the cultivating classes of the province. There are only two forms in which hand-removed excreta can be utilized, *viz.*, as a prepared manure (poudrette or artificial guano),* divested of all offensiveness, and presented in quite a new form in which its objectionable origin is so cloaked and disguised as to give the cultivator a fair excuse for ignoring it, or it must be removed by the cultivator himself from central places of deposit, and in its undisguised form of nightsoil merely mixed with earth or ashes sufficiently to retard decomposition, and make a sufficiently *dry* compost for loading and handling.

The advocates of the pail-system generally claim that it can be made to pay; and Professor Corfield says: "The evidence generally shows that this plan can be made to pay, and indeed generally *does* pay its cost at any rate. In the town of Groningën it is said the yearly profits amount to about £1,600; in Antwerp to £2,700; at Ostend to £700. In Strasbourg it is said the sale of manure covers the cost of removal; in Stockholm the expenditure is £35,000, and the returns £33,000. Nottingham, spending £6,000, gets a return of £4,000; and Salford is said to cover its expenses by the receipts."

* *Note*.—"Mr. Hughan has brought forward a new fertilizer, termed 'Huano,' formed by a combination of nightsoil with phosphates. Sulphuric acid is used as in the manufacture of common phosphates. The nightsoil serves to reduce the phosphates to a proper pasty condition for the action of the acid, which is then applied and sulphate of lime or plaster of Paris is then formed, and solidification and deodorization of the whole mass takes place."—(*American Government Reports*.)

This seems encouraging, and it might be argued that if it can be made to pay, as shown in other places, why not in Bengal; but there is a vast difference in the local circumstances and conditions that cannot be overlooked. The towns mentioned above are situated in agricultural countries, where the land is limited in area, and most valuable, where it is scientifically cultivated so as to yield the utmost possible return, and where there are no religious or caste prejudices to interfere with the handling and use of any manure so long as it can be made *to pay*.

But again, the example of China is often quoted, and, as an instance of thrifty economy of material and well-directed industry, with justice; but beyond this there is no parallel. The Chinaman cultivates with the most laborious care every yard of ground, every slope, every rocky shelf, capable of holding up a few cubic feet of soil. He manures every individual plant, and makes it yield its utmost. He has no silly prejudice against handling excretal matter, but preserves the waste products of his body with as much care as if they were (which indeed they are to him) the most valuable property. So minutely careful is the Mongol cultivator in this respect, that he carefully preserves the very clippings of his pigtail and the hair shaved from his body, and applies it as manure, a pinch being inserted into the ground with each seed or plantlet. "Indeed, it is only by means of this exceeding economy that the inhabitants of so densely populated a country can sustain life."—*Wood*.

I will only refer shortly to the economic results of filth utilization in this country as carried out at Poonah (the process of which I have already described) and other up-country towns. The cost of scavenging the

town of Poonah is Rs. 18,000, including the preparatory process; the return from sale of poudrette is Rs. 5,000. The cost of conservancy at Allahabad is Rs. 46,000,—*i. e.*, removal of sweepings Rs. 22,000, nightsoil Rs. 24,000. The *value* of the refuse is given as Rs. 13,800, but it is not asserted that any such return has actually been received. This is an assumed value given by Mr. Buck, the Director of Agriculture and Commerce, in a memorandum submitted to Government and circulated throughout the country for information. Mr. Buck, however, states, that at Farukhabad as much as Rs. 25,000 per annum *has been paid* for the nightsoil of the town by market gardeners of the Kāchhi caste.

The case of Farukhabad is very striking. Mr. Buck states, that “the city is divided into blocks, and the nightsoil of each block is the hereditary property of a family of sweepers or mehters. Each family collect the nightsoil in pits during the year, and in the month of October carry it out on backs of buffaloes and donkeys to the market and gardeners’ lands. At Agra the receipts from sale of manure were only Rs. 3,000, besides the quantity used to manure fourteen acres of land; and at Cawnpore they amounted to 4,000 to 5,000 rupees.

The undoubted success obtained in growing crops of all kinds on lands so treated must sooner or later force itself on the mind of the Bengal cultivator; and the existing prejudice against the use of land so enriched will, there is every reason to believe, gradually die down before the attractive picture of profits to be obtained from its use. But for some time to come these profits must be cultivator’s profits, and not profits to the town. There the profit must consist in the improved health and

comfort of the people, and in the improved value of the lands so enriched. We have first to induce the cultivator to accept the manure, and use it; to gradually create a demand for it; its value once fairly proved and established, and a healthy competition aroused, we may then look for a return of profit to the town from its extended sale.

But to effect this the attention of the cultivating classes must be attracted, and their interest aroused, in the benefits to be derived from the use of such manures; and the question how this is to be done is worthy of consideration; perhaps in this respect a little example is better than a great deal of precept:

“Example is a living law, whose sway
Men more than all the written laws obey.”—*Sealey*.

And in this view municipal farms, judiciously situated in the outskirts of towns, and carefully conducted, would do much to prove to the native mind the truth of these theories; but there is another method which, while it would entail little expense on municipalities, especially those which have their own printing-presses, would in these days of widely diffused primary education undoubtedly aid in spreading abroad amongst the cultivators a knowledge of the subject and would arouse a spirit of enquiry, *viz.*, the distribution of little pamphlets, or papers printed in the vernacular, and telling in a simple and popular form the wonderful results obtained in various places by the use of such manures. Such papers, if judiciously written in a form to interest, would be read in many a raiyat's family by the boys on their return from the patshala, for the edification of their perhaps unlearned

parents or uncles, and to display their own proficiency, and in the verandah of the *chundi mundop*, or under the shade of the bokool tree, where village gossips and village politicians congregate to discuss the prospects of the crops and the last rumour of a new *tuccus*. To those who have had no insight into the home life of the Bengali peasant, and who perhaps fail to picture to themselves the probability of such papers being read, and intelligently discussed by those whom they—it may be—regard as ignorant boors, caring for nothing but pice and their daily rice, I would recommend the perusal of a simple unpretending novel by the Revd. Lal Behari Dey, descriptive of peasant life in the Vardamana, or Burdwan district, called “Govinda Samanta, or the History of a Bengal Raiyat,” and particularly Chapter XIX, Evenings at Home, and the conclusions of Chapter XXV. These papers might be distributed at the markets and hâts as well as through the village schoolmasters and local dispensaries. The Bengal raiyat, prejudiced as he may be, wedded to old customs as he undoubtedly is, can understand the value of manures, though he may not appreciate the beauties of a steam-plough.

The fertility of all soils depends on constituents which they usually contain only in small proportions. These constituents are withdrawn from the soil by the growing crops, and with every recurring harvest the ground (unless there be a compensating element at work) must be so much the poorer. The alluvial soil of Bengal is, perhaps, one of the most prolific in the world; but sooner or later the most fertile ground, unless recuperated by natural means, such as the deposit of suspended matters by the overflow of the river, or artificially

enriched by manure, must show the effects of this repeated drain upon its resources. This decreasing fertility is a most serious consideration, especially in a country where population is not only increasing, but where high prices, caused by diminished production and increased exports, decrease local supplies and enhance the prices of food, thus making it more difficult for the poor to obtain sufficient nourishment; and where the growing fiscal wants of the country lead to constantly increasing taxation. The cause of decreasing fertility of soil may be ascribed to want of a proper rotation of crops, insufficient manuring, and constant cultivation of the same ground, the land never having any rest. The only remedies for this are,—a suitable rotation and liberal use of fertilizers, and of all the manures within reach of the Bengal cultivator, the most valuable, while the most neglected, is human excreta. ‘As man is more richly fed than the lower animals, so his fæces are the most valuable as manure;’ and when his indebtedness to the soil, which gives him nearly all the necessities and even luxuries of life, is thus easily repaid, it would be but common honesty on his part, even were it not to his own immediate advantage, to return to the soil that which it so urgently needs, and which is to him not only useless, but a burden and an abomination. One of the greatest practical and scientific farmers of the present day, Mr. J. J. Mechi, says:—“It is the want of will and belief that keeps sewage in our rivers instead of on our land; I call it national suicide. It is not only the duty, but the interest of landowners and tenants to receive and pay for a valuable and effective producer of human and

animal food. I wonder that any one can doubt it, when we know that its application to land very soon increases the crops, raises the rent, and consequently the fee-simple value of the land which receives it. Look at the Craigentenny meadows at Edinburgh in their natural condition, they were a sandy waste, utterly unproductive. Now, since the application of the town sewage, the average letting value for *six months* of the year is at £22-10 per acre by public auction.”* In one of the reports of the Department of Agriculture and Commerce, United States of America, I find it stated that, in Brunswick, Maine, “there was but one man in the town who had acquired wealth by farming alone, and that he had accomplished this by using large quantities of nightsoil on his grass lands and cabbage fields.” As a fitting conclusion to this part of the subject, I will quote the words of one of the wisest men of whom England can boast—Lord Bacon :

“And of all sorts of thrift for the public good, I would, above all others, commend to your care the encouragement to be given to husbandry and the improvement of land for tillage. There is no such usury as this. The king cannot enlarge the bounds of these islands, which make up his empire, the ocean being the unremovable wall which surrounds them; but he may enlarge and multiply the revenue thereof by this honest and harmless way of good husbandry.”

* Mr. Mechi, of Tiptree Hall, Essex, formerly Sheriff of London, and an Alderman of that city, died on Sunday, the 26th December, 1880, whilst these sheets were in the press. He was an enthusiastic and practical agriculturist, and a strong advocate of sewage utilization.

CHAPTER XIV.

"In spite of the magnitude of the Water-works of the Romans, Greeks, and other ancient peoples, the aqueducts, the storage reservoirs, the public baths; and in spite of the lavishness of the supply for public uses and in the houses of the rich, it is probable that there has never been such general and widespread interest as there is to-day in the matter of water-supply as a sanitary necessity, not only to the community as a whole, but to the individuals, no matter how poor, who make up the community."—*Prof. Nichols.*

The want of wholesome water is without doubt one of the most serious insanitary conditions of nearly all towns and villages throughout the country, and it is aggravated by the general carelessness of the lower orders who take little heed of what they drink or cook with, and who are apt to resort to the nearest waterhole or stagnant pond rather than go any distance for water of better quality, even where it is to be found. Dr. Buchanan, in his "Journey through Mysore," remarks, "that the unwholesomeness of the water in many places is to be attributed in part to the common nastiness of the Hindus who wash their clothes, bodies, and cattle in the very tanks and wells from which they drink."

To whatever cause we may attribute the change, there is ample evidence throughout the country that the people are much more careless of their drinking-water supplies in these days than formerly. The fine old tanks sur-

rounded with raised embankments and with fine substantial masonry ghats that still exist, though generally in a state of decay, are proofs of this state of things ; and there can be little doubt that this depreciation in the quality of the water-supply, and this careless use of impure water, accounts in a great measure for the prevalence of cholera and bowel complaints throughout Bengal.

The sources from which the people obtain water for drinking and domestic purposes are rivers, tanks, jheels, and wells.

In purely rural tracts it may be that there is often nothing more hurtful in the water than vegetable matter and animal organisms, which, though possibly hurtful, can hardly with justice be called impurities, inasmuch as they are the natural accompaniments of all natural waters. No natural water is chemically pure, and to obtain a public watersupply, perfectly free from organic and inorganic matters, is an impossibility. "Perfectly pure water," says Dr. Kanailal Dé, "is hardly to be found."

But to any one who is familiar with the country and the habits of the people, it will be plain that other sources of pollution are but too numerous even in strictly rural tracts. The people habitually defæcate on the slopes and margins of the tanks, and after relieving nature, they commonly cleanse themselves in the water. Men, women, and children bathe, and in bathing urinate in the tank ; they wash their clothes and domestic utensils ; cattle are driven down to drink, or they stray down to the water and cool themselves by immersion, and micturate and defæcate in the water.

When the river is far distant, the Hindu dead are cre-

mated on the margins of the tanks, and their rags and pillows left to rot; and in many parts of Bengal the Mahomedan dead are buried close to the water—in the rains the earth becomes saturated; the hollow grave fills with water, which laden with organic matter and the products of putrefaction, percolates or overflows into the tank. A late Sanitary Commissioner of Bengal informed me, whilst these pages were being written, that he had personally counted on the margin of one tank in the Burdwan district the recent graves of thirty Mahomedans who had died from the cholera epidemic then raging. That they were *all* within nine feet of the water, the closest being two feet only from the water's edge.

River water is similarly polluted, though in this case from its rapid motion, greater volume, and more complete oxidation, the evil is not so great as in the case of the water of tanks or reservoirs. In the Dacca district pauper corpses are sunk in the river near the public ghats, with bamboo stakes driven through the abdomen into the bed of the stream, the people having no scruple in drawing water from their vicinity.—(Dr. Wise's Report.)

Within towns and the more thickly populated suburbs, however, the sources of contamination are much more numerous and much more hurtful, and it would be almost an impossibility to preserve the water of any ordinary tank or pond from pollution of a most dangerous character. As noticed in the Chapter on Drainage, tanks are too often made the catch-water basins of all the surrounding drainage, the foulest portion settling in the tank as only the spill water runs off the surface. They are universally used for washing and bathing in, and

where the population is dense, the amount of animal pollution thus contributed may be understood, the more so that it is in evidence that natives invariably urinate in the water whilst bathing.

People ease themselves on the banks, and Dr. Wise remarks of Dacca, that "cesspools are found on banks of tanks, and within a few feet of wells; and privies, if made at all, are constructed near a tank into which the first rain carries the sewage." In the suburbs of Calcutta privies were not unfrequently to be found *overhanging* tanks or situated along the course of wet ditches communicating with them.

Cowhouses are constantly located close to them, the decomposing dung and urine finding their way freely into the water. They are thus subject to defilement from both surface impurities and subsoil percolation. We have the authority of the present Surgeon-General of Bengal for the statement that "many of the tanks in Calcutta were filthy, stagnant pools of sewage," the water from which "was found to be, on analysis, a liquid occupying an intermediate place between urine and liquid sewage." Yet we will find people bathing in such filthy pools, washing and rinsing their mouths, cleaning their cooking vessels, and washing rice and vegetables in the foul liquid, if not actually drinking it.

Mr. Alexander Pedler, F.I.C., F.C.S., London and Berlin, has lately published a pamphlet on "The Past and Present Watersupplies of Calcutta," in which he gives the results of analysis of two hundred samples of water taken from different tanks throughout the town and suburbs.

Mr. Pedler says:—"Taking the results obtained by the

Total Ammonia Test, and judged by the standards which have been put forward by Professor Wanklyn, and the additional somewhat rough ones suggested by myself, it will be seen, as might be expected, that no single tank or well water was of extraordinary organic purity, and that there were only seven tank-waters included under the head of "safe" waters, five of which were from tanks on the *maidan*. Of *dirty* waters there were twenty-six out of the two hundred, or 13 per cent. Of waters considerably contaminated with sewage matter, sixty-four, or 32 per cent. Of *dilute sewages*, there were thirty-two, or 16 per cent., and of *real genuine sewages*, seventy-one were found, or $35\frac{1}{2}$ per cent., that is rather more than one-third of the whole number." "I have no wish to enlarge to any extent on this decidedly nauseous topic, but perhaps the most striking condemnation of the well and tank-waters of Calcutta, and which will appeal to every inhabitant, whether scientific or otherwise, is to say, that a good average quality of Calcutta tank or shallow well-water may be made by mixing six parts of our present hydrant water with from one to two parts of the *most* concentrated Calcutta sewage. This artificial tank or well water will be of about the average composition. It will also be, so far as can be judged, equally healthy for potable and domestic purposes, and as for its taste, odour, etc., it will probably be rather superior to the general run of Calcutta tank and well-waters."

Can any testimony be stronger than this? I opine not; and we may take the tanks and wells of Calcutta to be no worse than the average of tanks and wells situated in any populous native town.

It is difficult to account for this carelessness in such

an important particular on the part of a people whose daily life is so strongly tinctured with ceremonial observances, and who are theoretically so careful to avoid contamination and impurity in their food and persons, and especially as the defilement of tank-water in the manner above described is such a distinct breach of the injunctions of the Hindu Shastras. Dr. Kanailal Dé in an address delivered at the Third Anniversary of the Bengal Branch of the British Medical Association, said : " Tank water, or water from artificial reservoirs, is not pure or holy in the meaning of the shastras, and is, therefore, not usable in religious rites or ceremonies. It may be used for drinking and other domestic purposes where ' Gunga' water is not available ; but the greatest strictness is enjoined by the shastras for keeping it clear of all impurities. Menu says, a man should not cast into such waters either urine, or ordure, or saliva, or cloth or any other things soiled with impurity, nor blood, nor any other kinds of poison."

We can, therefore, only ascribe this general carelessness on the part of the people to a blind mistaken religious belief in the innate purity and undefilability of all large bodies of water, (but which really only pertains to Gunga, or Ganges water,) and to heedlessness and fatalism. Careless as the lower orders of the people, especially the residents of towns, are of the sources from which they draw their water, there are no greater connoisseurs in regard to the various qualities and excellencies of potable waters than the Bengalis, as is illustrated by the following classification of the distinctive terms in common use by the natives of Bengal, quoted by Dr. Bholanath Bose, in his Report on Fur-

reedpore. (Sanitary Commissioner's Report, 1868.) The various qualities and classes of water are thus described :

Sroth jol, running or stream water. Buddho jol, stagnant water. Photick jol, perfectly clean water. Ghola jol, turbid or muddy water. Moyala jol, dirty water. Shaph jol, transparent or clear water. Nona jol, salt or brackish water. Meetha jol, sweet fresh water. Bhar-ree jol, heavy water. Hulkee jol, light water. Gobbeer jol, deep water. Solpho jol, shallow water. Buddh jol, bad water. Bhallow jol, good water. Ghonno jol, thick water. Patla jol, thin water. Kadda jol, muddy water. Pocha jol, putrid water. Shayala jol, water full of weed. Panna jol, water covered with panna (algæ). Boda jol, stagnant water, with a peculiar disagreeable styptic taste. Sonda jol, foetid water.

We may take it as an incontrovertible fact that the conservation of small ponds or tanks in populous neighbourhoods is an impossibility, so far as keeping their water in a fit state for drinking purposes is concerned; much may, however, be done to keep such tanks from being a source of actual nuisance.

All tanks intended for public use should be railed in, to prevent cattle from straying into them; the bank should be raised to prevent surface impurities from washing into them, and all cesspools, privies, and foul cutcha drains or other receptacles for filth, sewage, house drainage, or other offensive matter, within a radius of at least fifty feet, should be strictly prohibited.

The local authority in Bengal has power in the latter respect under section 246, Act V of 1876.

That fertile cause of pollution, the use of the tanks by *dhobies* or washermen, should never be permitted,

nor the steeping of green bamboos to fit them for building purposes, or the steeping and rotting of jute, flax, or other plants for the purpose of separating their fibre.

In towns, where there is any system of nightsoil removal, careful supervision is necessary to prevent *haris* or nightmen from washing their tubs and brooms—a whole tank may not only be polluted, but infected with enteric fever or cholera germs from such a cause.

The above remarks refer only to such tanks as are set apart for bathing and domestic purposes other than drinking or cooking; and notices should be placed at the ghats warning people against drinking the water.

Drinking tanks require much more careful watching, as well as more thorough arrangements, both of construction in the first instance and means of conservation.

To secure good water in a drinking tank, a large area is required both for storage and to serve as a catch-water area. Where practicable, therefore, the water surface should not be less than three biggahs, with a catch-water area surrounding it of equal extent.

No water should be permitted to enter the tank except the direct rainfall over the conserved area supplemented by wells in the bottom. It might perhaps be doubted whether a sufficient supply could be obtained from these sources alone, but there need be no fears on this head.

I will give as an example the instance of a tank constructed near Calcutta in 1875, and which will illustrate the possibility of thus securing a sufficient supply better than mere theories. The site acquired for this tank was nearly seven biggahs in extent, and was a compact square of low land, about six feet below the

level of the surrounding lands, and the adjacent public road. Of this area six biggahs was marked out for the tank and catch-water surface. The tank or reservoir was then excavated to a total depth of twenty-seven feet with a surface area of three biggahs and three and-a-half cottahs. The banks were formed with a slope of two to one, with a four feet berm at eighteen feet; where the footings of the ghats were laid. The remaining land was raised several feet above the surrounding level, with a gentle slope from the edge of the tank outwards to an artificial stone channel on all sides of the conserved area, the water falling over this area being caught by the stone channel and led by masonry shoots at the corners into the reservoir; by this means erosion and guttering of the banks is effectually prevented. The supply of water derived from the direct rainfall is supplemented to some extent by four deep wells in the bottom of the reservoir, which is calculated to hold over four millions of gallons of water. The reservoir was planned on the following calculation: The rainfall in Bengal for the ten years previous to construction had varied from 45·55 inches to 93·31 inches, the average, therefore, was taken at 70 inches per annum. It had been ascertained by experiment that, with a rainfall of 70 inches, the amount of water falling over a measured area of 1,200 square feet amounted to 43,628 gallons. Taking the catch-water area, therefore, to be six biggahs, or 86,400 square feet, the amount of water falling over it with the same rainfall would amount to nearly $3\frac{1}{2}$ millions: we may assume the loss by evaporation and absorption to be counterbalanced by the springs and wells, and as the entire supply is not consumed, the rainfall is ample

to maintain the water level. Although we have had, during the past year, the shortest rainfall known for some twenty years, this reservoir has never had less than seventeen feet of water in it at its lowest, and its water is in use by a large neighbouring population.

In constructing tanks due heed must be had to the soil and to the surroundings. A tank, wholly or partly excavated in what is termed made-up ground, that is, originally low land raised in the course of years by refuse deposits, will hardly ever yield good water, and the subsoil of nearly all our old Indian towns is so fouled by the soakage of the sewage or filth of generations, that great care is necessary in selecting a site. If the soil be loose and sandy, and there be a number of filthy ponds or cesspools in the vicinity, there will always be the danger of sewage percolation from them into the new excavation. This may, of course, be prevented to a great extent by well puddling the bottom and sides of the reservoir, or by the use of a puddle core in the embankment; but this adds greatly to the cost of the work, is not always easily effected, and from the slipping of the banks or the disturbance of the puddle coating is not always effectual in preventing filtration. A new tank, therefore, should always be dug, where possible, in fresh new ground, and all cesspools and filthy ponds in the vicinity should be emptied, cleansed, and filled up with earth. This can generally be easily effected whilst the excavation is in progress, and the spoil earth is available.

Where a tank is to be excavated near a river and in sandy soil, advantage may sometimes be taken of the tendency to filtration to secure a constant supply of

water partially filtered, and therefore cleared of the silt and mud, held in suspension by the river water.

A rather curious instance of this exists in a fine large reservoir constructed by me, some years ago, in Garden Reach. There had existed, for many years, at the back of the Government Dockyard premises, a very extensive jheel or swamp, and which, as its name, *the Adhygunga*, implies, was, in former years, a portion of the original bed of the Ganges. At what period it was cut off from the river I do not know; but a good many years ago, when the Dockyard premises were enlarged, the old Garden Reach road was diverted and carried across a portion of the swamp, which had been, in the course of years, filled up by the deposit of sand from the docks, mixed with the cinders and slag from the furnaces and cupolas. The swamp was long an eyesore and a source of malaria and sickness to this part of the suburbs. In 1875, the Government offered the site, some fifteen biggahs, to the Municipality free, on condition, that a tank should be formed in one portion of the ground, and the rest of the swamp raised and reclaimed. The work was accordingly taken in hand, a portion of the native village adjoining purchased and removed, and a fine rectangular reservoir, with a water surface of nearly six biggahs surrounded by walks, grass, and ornamental shrubs, now occupies the site of the old, unsightly, and pestiferous swamp. Owing to the nature of the soil, a wet sand, it was found impossible to get deeper down with the excavation than seventeen feet, the water below this depth rising fast in the cuttings. Whilst making the excavation, undeniable proof was discovered of the swamp having formed in

bygone days a portion of a river bed, for, at a depth of ten feet below the surface of the bed of the jheel, several portions of sunken boats came to light, and in one spot an entire boat, measuring some thirty feet in length, was disinterred, containing, besides the remains of firewood, rice-bags, earthen utensils, &c., the complete skeleton of a man, portions of two other human skeletons being found underneath and close to the boat.

At one corner of the tank, a most persistent spring of clear water interfered greatly with the work, the water filling up the cuttings as fast as it could be baled out; and, on investigating the cause, the spring was traced back to the bed of cinders and slag underlying the Garden Reach road. Adjoining this is a large settling tank for the river water used for the foundry boilers, and which is pumped daily from the river, the water passing through the thick bed of cinder, slag, and sand, is, therefore, effectually filtered. A pipe culvert was laid to conduct this water into a settling well, from whence it passes into the reservoir through an overflow pipe. There is thus not only a constant accession of fresh filtered water into the reservoir, but a continual, though imperceptible, current through it, which assists in keeping the water clear and fresh. The supply is so constant, that, in the hottest and driest seasons, the water level only sinks from two to three feet.

The two examples given will serve to show what can be done to improve a tank water-supply and at a comparatively small cost, the two tanks mentioned having been completed, inclusive of purchase of land, construction of ghats, drains, railings, and turnstiles, for something less than Rs. 8,000.

In all tanks or reservoirs, water plants and fish in moderate quantities are a necessity: the former exert a distinct chemical influence on the water, while the latter not only prevent overgrowth of vegetable matter, but consume a large quantity of insects, crustaceæ, and organic matter.

That well-known Indian Chemist, Dr. David Waldie, of Cossipore, says:—"Some of the best tanks, General's tank more particularly, are probably equal to the river water in purity at some seasons, and superior to it at others. Tank water deteriorates in the hot season from putrefactive fermentation, the river water proper improves from oxidation, but near Calcutta deteriorates from sewage and tidal water. Tank water improves during the rains by dilution with rain water, *and the animal and vegetable life in it preserves the proper balance, removes decaying matters, and prevents putrefaction to any great extent*; at least this is the case in good tanks. *General's tank seems a well kept aquarium: it abounds in animal life.*"—(Asiatic Society's Journal.)

Dr. Wilson says,—“the purifying process is aided to some extent by the presence of fresh water plants;” and again, “among other purifying agents may be mentioned the effects of plants and fish.” In store reservoirs, the presence of a moderate quantity of living plants exerts a decidedly purifying influence, while the destruction of fish has been followed by an excessive multiplication of the small crustacean animals on which the fish had lived, thereby rendering the water nauseous and impure. The remedy was found in re-stocking the reservoir with fish (Rankine).—(Wilson's Hygiene.)

Of the water-plants best suited for preservation of

tank water, the following are best known to me : *Nymphaea rubra* (Bengali, rukta kumbula), which has long india-rubber like stems, varying with the depth of water and deep red or blood-colored flowers, hence the Bengali name ; *Vallisneria alternifolia* (Bengali, rusna jhanj), stems rising with the water ; *Vallisneria vertecellata* (Bengali, dhap or daam) ; and *Vallisneria octandra* (Bengali, patta sewala), the water-plant used by the Jessore sugar-refiners to cleanse their raw sugars. Westland, in his account of Jessore, gives the name of the weed as syala: and, according to Roxburgh, it is a grass-like plant, growing in standing shallow water.

The beauty of the *Nelumbium speciosum*, water bean (Bengali, pudma), would seem to make it a desirable plant for reservoirs ; but it should, nevertheless, be avoided, as it tends to accumulate mud, and injures the water.

In addition to the higher order of plants which I have enumerated above, there are a number of harmless confervoid growths belonging to the class of cryptogamous or non-flowering plants, known as algæ, which flourish in water, and generally in tanks or ponds, where they float about in masses, sometimes covering the whole surface with a deceptive carpet of verdure. By their growth they do no harm to the water, but rather act as a preservative, for when this green veil is swept aside, the water beneath will generally be found far clearer than in tanks free from weeds. I believe the crusade against "pannas," as they are universally called, to be a decided mistake ; the danger lies, as in the case of jungle clearance, in the plants being gathered from the surface or lodged on the banks as the water level sinks in the tanks, and there allowed to die and decay.

Professor Nichols considers that there is no reason to believe that the presence of these minute algæ gives an unwholesome character to the water. They are not, in his opinion, a sign of impurity, as they grow in ponds which are far removed from all sources of contamination. —(*Buck, I., 238*).

All water-plants, stranded on the banks as the water sinks in the tanks, should be carefully cleared away and not allowed to rot.

Of the fish best suited for stocking tanks, the katla, ruho or rooi, kalaboas, mirgal, all of the carp family (Cyprinidæ), are the most desirable.

The young fry of these fishes are largely sold during the months of July and August by fishermen who net them on the shallows in the Hooghly and in the Damoodur and other tributaries. They are carried about for sale in large flat shallow vessels of black earthenware filled with water, and kept constantly in motion.

Wells, as sources of supply of drinking-water, are not in favor with the Hindus of Lower Bengal, but there may be localities where they are the only means of procuring a supply. Wells are very subject to sewage contamination, and often contain nitrites and nitrates of ammonia, lime organic matter, and, where situated near graveyards, fatty acids.

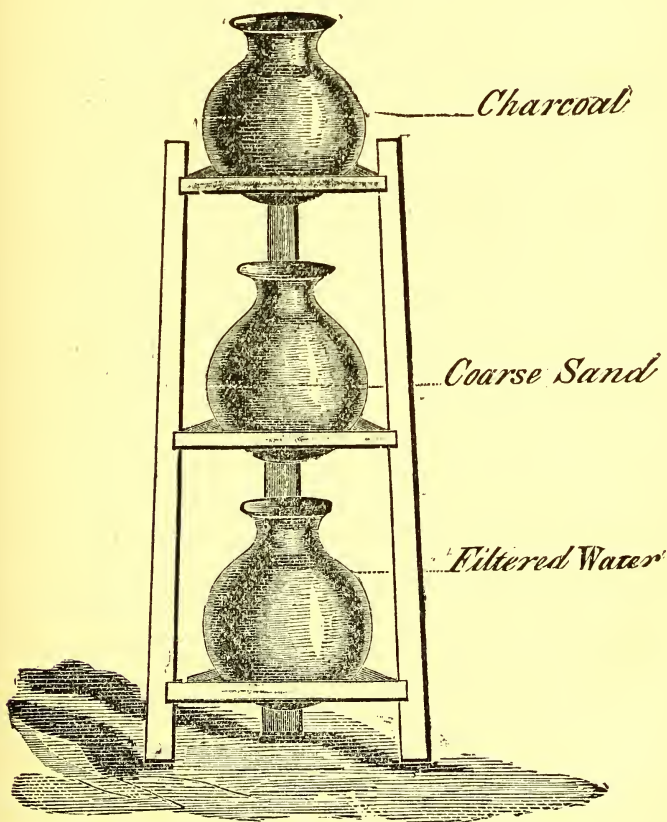
Where a well exists in fouled ground, the only course is, to abandon it and dig a new well in clean ground, and away from all possible source of pollution; the subsoil water and all impure percolation must be cut off by casing the well to a depth of 10 feet from the ground level with brick-work, with cement joints, concrete, or, what is cheaper and better than all, with *puddle*.

In constructing a well with puddle, the common baked earthen well-rings or "tikras" must be used, and the excavation being made about three feet larger in diameter than the well-rings, the puddle stuff must be rammed firmly down and well worked.

Puddle to be impervious must be carefully and thoroughly worked, as well worked as the clay for a well moulded brick. Surface alluvial soil will not do for the purpose; a light loam or clay, with a slight admixture of coarse sand or fine gravel, is the best. This must be well worked with sufficient water, and trodden up by the coolies' feet to a stiff tenacious mass: it must then be packed in behind the rings and thoroughly worked or punned down, taking care not to crack or break the rings in doing so. The well tube should be carried up two feet above the ground level, and a protecting ring of brick-work built round it, and the surface sloped and paved, or concreted, to prevent waste water from draining back into the well; the mouth of the well should be covered over, and either a pump fixed over it or a windlass with a bucket and chain; the only objection to the latter is, that it is apt to swing against the sides and break the earthenware rings, which are somewhat fragile.

There can be no doubt that, if the people could be induced to boil and filter the water used by them, that many dangerous waters might be thus used with comparative safety; but this cannot be expected, the very cost of fuel would prevent the poorer classes from taking this precaution; nor is it at all probable that they could, to any extent, be brought to filter their drinking water, although the materials for constructing a most efficient filter is to their hand, and at an outlay of but a few pice

—a rough wooden stand, three ordinary porous earthenware *culshis* or jars, a small quantity of charcoal or sand being all that is necessary.



The local authority might, however, greatly improve the supply from public tanks by constructing filtering draw-wells in connexion with the tanks from which the

water should be drawn by a pump or iron bucket and chain, after being filtered through gravel, coarse sand, and charcoal.

Good drinking-water should possess the following characteristics: it should be tasteless, odorless, clear, transparent, and without any color, or as the Spaniards say *ni sabor, olor, ni color*. It should be cool and well aerated, and free from deposit and living organisms. A drinking-water may contain a greater or less amount of dissolved mineral matter without detracting from either its wholesomeness or palatability. A perfectly pure water, such as is obtainable only by distillation, is, it is well known, most unpalatable, owing to its entire want of aeration and the absence of the dissolved gases and mineral salts which occur to a greater or less extent in all natural waters. The water obtained for ship's use by distillation of the sea-water in Normandy's condensers, is, until aerated by artificial means, not only unpalatable, but by some authorities supposed to be indigestible. One of the pleasantest and most wholesome waters is rain or cloud water: it is in fact the purest of all except distilled water. When received on a clean collecting surface, and carefully preserved from contamination, it is pure, soft, and highly aerated, possesses high solvent powers, and hence is valuable for cooking and in chemical operations. Those who have become accustomed to drink rain-water from clean cisterns or reservoirs, prefer it to deep well-water, and claim that it is a better thirst-quencher, as well as a restorer and preserver of health and a preventive of many diseases. An American writer, in an article in the United States Government Reports, states, that "it is a well-established

fact among intelligent medicalmen, that the stomach and bowels are far less liable to derangement and disease, and to attacks of epidemics under the uniform use of rain-water than of hard-water." This is confirmed by numerous medical and scientific reports in different countries.

"It has been clearly ascertained both in Paris and elsewhere, that rain-water is a prophylactic (antidote) to cholera: and that the disease was not proved an epidemic in any city where rain-water was exclusively used." Dr. Hobbs of Memphis states,—“By the exclusive use of cistern-water (*i.e.*, rain-water), cholera will speedily disappear and not return;” and Dr. Lea, of Cincinnati, declares,—“That it is a verified fact, which will stand the strictest investigation, that the exclusive using of rain-water for all purposes of drinking, cooking, and bathing, instead of hard or well-water, is a sure preventive of cholera and bowel complaints; and that no town or city supplied exclusively with rain-water ever suffers seriously from epidemic cholera.” The late Dr. Parkes, of Netley, also gives valuable testimony in favor of the use of rain-water in preference to spring or well water. He says,—“The greatest benefits have resulted in many cases (especially in the West Indian Islands) from the use of rain, instead of spring or well water, which is often largely impregnated with earthy salts.” Of course, these opinions hold good only in regard to rain-water as received from the clouds and so collected and stored as to prevent its being contaminated by organic and other impurities.

Davis mentions as a curious fact in reference to the West Indies, that “ships’ crews, when ordered to Tortola, were ‘invariably seized with fluxes,’ which were caused by the water. But the inhabitants, who used tank,

i.e., rain water, were free, and so well was this known that, when any resident at Tortola was invited to dinner on board a man-of-war, it was no unusual thing for him to carry his drinking-water with him."

Not many years ago before the present filtered water supply was provided for the city of Calcutta, nearly all the old residents used to store the rain-water collected from the flat terraced roofs of their houses in large earthen jars, or jallahs, the care of which was one of the principal duties of the now-extinct, but formerly important domestic official, the *abdar* or waterman; and nearly every house had a special *abdarkhana* or water-house set apart for the keeping of the drinking-water jars. There were indeed several old European Calcutta residents alive up to a very recent date, if they are not so still, who, having for many years been accustomed to drink nothing but rain-water, continued to do so even after the introduction of the filtered public supply; and an advertisement of about seventy years ago shows, that the aerated soda-water manufacturers of that day held out as an inducement to consumers that their soda-water was prepared from *rain-water* only.

Many large cities in the south of Europe are entirely supplied with rain-water, such as Constantinople, Venice, Cadiz, and other places. In the latter city the roofs have a self-acting tilt-trough, which throws off the first rainfall with the impurities washed from the roof, before allowing the water to run into the reservoir. The Spaniards, who have a proverb for every thing and every occasion, say of rain-water, that it neither makes men sick, nor indebted, nor women widows: "*Agua que no enferma, no adeuda, no enviuda.*"

CHAPTER XV.

“No tree in all the grove but has its charms.”—*Comper*.

“States, societies, and individuals have encouraged by bounties the planting of trees with sufficient success, at least to excite thought and stimulate effort upon the subject of practical arboriculture.”—*American State Reports*.

There are several objects to be attained by a systematic planting of trees on the road sides, the public squares, and on waste and unoccupied lands, recently reclaimed ground, and old and unused burial-grounds.

First, we have in view the beautifying of the town, the provision of grateful shade, and the diffusion of sweet scents. *Secondly*, the purification of the atmosphere by the absorption by plant-life of carbonic acid and ammonia, and the diffusion of oxygen and ozone. *Thirdly*, the drying of the subsoil, and the withdrawing from it, by the same powerful agency, of the elements of decomposition. *Fourthly*, the preservation of the road surfaces. *Fifthly*, the equalization of the rainfall. *Sixthly*, the interception of malarious air currents by belts of trees; and *seventhly*, the production of valuable and useful timber and refreshing or nourishing fruits.

The *first* of these objects must be patent to every one. What can be more dreary and depressing than a town destitute of trees and vegetation, and what visitor to

Calcutta in the months of March, April, and May has not been struck with the wondrous blaze of color exhibited by the simul or cotton tree, and the Poinciana regias glowing above the soft refreshing verdure of the numberless foliage trees with which the town and its surroundings abounds. What traveller has not blessed the grateful shade of the umbrageous banyan, the bokal or the tamarind; and what manner of man is he who has not scented up with delight the cool evening air laden with the delicate perfume of the magnolia, the har singha (*Nyctanthes arbortristis*) and the jasmine, or the more potent honey-like fragrance of the champa and the kuddum.

Of the *second* object sufficient explanation has been given in the chapter on Rank Vegetation. Of the *third*, the explanation is easy. Plants transpire freely when they have a moist soil to draw water from, and a dry atmosphere around them. For example, it has been calculated that a beegah of grass will part with moisture to the atmosphere at the rate of 4,266 pints per day. A single sun-flower plant transpires about one pint of water daily, nearly all this water being drunk up from the soil by the roots, the speed of the circulation being nearly twenty-four inches per hour. Experiments recently made show, that "plants in a saturated atmosphere transpire most when exposed to the sun, and that in the shade transpiration ceases when the atmosphere is loaded with watery vapour." Trees also affect the drainage of the soil by mechanical action, the roots permeate the subsoil and open up numberless drainage channels through otherwise impervious strata. In fact, they perform the office of draining in a manner analo-

gous to that artificially practised in parts of Holland and the British Islands. This method consists in driving down deeply into the soil several hundred stakes to the acre; the water filters down along the stakes, and in some cases as favorable results are said to have been obtained by this means as by horizontal drains (d'Heri-court, *Annales Forestieres*, 1857). It will be found that the earth is always much dryer near the roots of trees than elsewhere; and it is an established fact that cutting down woods and forests has, in many known instances, converted considerable tracts of well-drained land into swamps and marshes.

The preservation of the road surfaces is effected by shielding them from the baking torrid heat of the summer sun and retarding evaporation from their surfaces. The equalization of rainfall is, undoubtedly, affected by the planting or denuding of a district of trees. On this head all good authorities are at one. Humbolt, Herschell, Bousingault, and others are agreed that the destruction of forests is followed by diminished and less equable rainfall; and it is known that in forest regions the ground covered with trees receives more water than the uncovered ground of regions with little or no wood. The rainfall is also greater over forests when the trees are in full foliage. The late Pasha Mehemet Alli made extensive plantations in Lower Egypt with a view to increase the rainfall. Previous to this there was hardly any rain, often none for more than a twelve-month; now that the forests have grown up, the annual average is said to be thirty days rain in the year. On the contrary, it is asserted, that, in Upper Egypt, the rains, which a century ago were abundant, have ceased since the Arabs cut down

the trees along the valley of the Nile toward Lybia and Nubia. Some years ago, Saint Helena was almost denuded of timber, the consequence being a very great diminution of the rainfall, which, when it did fall, came down in a deluge. Since tree-planting has been steadily progressed with, the rainfall has again become regular and equable.

It is a well-known fact that belts of trees, interposed between inhabited localities and marshes or swamps or surrounding burial-grounds and cemeteries, intercept the noxious exhalations and malarious air currents when the wind blows from their direction. Monsieur Regaud de l'Isle, writing about the malaria of the Campagna di Roma, says: "Various obstacles form barriers which miasmata cannot pass; the interposition of a forest may preserve us in a variety of circumstances from the pernicious effects of air currents charged with deleterious miasmata. Upon Mount Argenteo, above the village of San Stephano, there is a convent, which has lost all its reputation for salubrity which it once enjoyed, since the lofty trees by which it was surrounded have been cut down. In consequence of the felling of the woods before Asteria, near the Pontine marshes, Velettri was visited for three successive years by diseases unknown before." Volney states a remarkable fact relative to this subject: Beyrout, formerly very unhealthy, quite ceased to be so since the planting of a wood of fir trees by the Emir Fuqr-ed-din, about a league below the town. Dr. Ferguson, in a paper on Marsh Poison, in the *Medical Chirurgical Review* (1821), remarks, that "the town of New Amsterdam in Berbice is situated within short musket-shot to leeward of a most offensive

swamp, in the direct track of a strong trade-wind that blows night and day. Yet it brings no fevers, though every one is well aware that it would be almost certain death for a European to sleep, or even to remain, after nightfall, under the shade of the lofty trees that cover the marsh at so short a distance. All too are equally aware that to cut down the trees would certainly be productive of pestilence to the town."

These are somewhat antiquated authorities, but they are none the less sound; and the views enunciated by them as to the protective influence of belts of plantation are still received by sanitarians without question. Dr. Parkes, of Netley, says,—“The protective influence of a belt of trees against malaria is most striking;” and Dr. Adam advocates the surrounding of burial-grounds with trees to act as a barrier to the escape of miasmata.

Whether the action is purely mechanical, or whether, as some suppose, trees possess the power of neutralizing malarial poison by some chemical agency, has not been determined.

Eminent medical men have of late years advocated the planting of belts of trees between the great swamps known as the Salt Lakes lying to the east of Calcutta and the suburbs, and we can hardly doubt that the result would be beneficial. Unfortunately, in the vegetable as in the animal kingdom, beauty does not always go hand-in-hand with utility and strength; and many of our most ornamental flowering trees are of little or no use either as fruit or timber producers, and in proportion to their rapidity of growth and the fragility of their wood, they are liable to quick decay and

damage by high winds and the cyclonic disturbance to which the weather in Bengal is so subject.

First and foremost amongst the purely ornamental trees we may note the *Poinciana regia*, or Flamboyant as the French call it, which flowers in April and May, and is then a gorgeous blaze of scarlet and yellow ; and after flowering is still a handsome object for some months of the year from its bright green feathery foliage. It bears seed abundantly in some seasons, but is somewhat difficult to raise, and is extremely fragile, when it grows large enough, to oppose resistance to heavy winds.

The *Colvillea racemosa*, a tree much resembling the last in foliage, is a stately object, bearing high aloft in September its noble drooping racemes of orange-colored flowers, but remains bare of foliage for a considerable part of the year.

The *Cassia fistula* (or *amultâs*) presents a truly magnificent mass of pendulous laburnum like yellow blossoms in all May and June, succeeded by long black cylindrical seed pods, as round as a ruler, and from one and-a-half to two feet long.

The *Cassia marginata* is a somewhat small tree but occupying considerable space from its widespreading habit. Blossoms profusely, principally in the rains, but also through the hot weather, with numerous rose-colored flowers, and is a very ornamental object, better suited for a shrubbery or open ground than for a roadside.

Lagerstræmia regina (jarool), a handsome tree, bearing a profusion of rose-colored or purple blossoms (*see also* Timber Trees).

The *Cassia Javanica* is a handsome forest tree ; a mass

of beautiful pink blossom in April and May, and bearing large heavy rugose bean pods.

All these trees, however, are of little beauty, except when in flower, and give little shade.

The following trees are all suited for road-side planting being handsome, hardy, and giving good shade :

The *Dellenia speciosa* (chaltâ).—A hardy handsome tree, with large-ribbed chestnut-like leaves, noble white scented flowers, blossoming in July, succeeded by large green sepalous apple-like fruits.

The *Magnolia pterocarpa*, a handsome tree, with large smooth glossy leaves, and globular white fragrant flowers ; blossoming in April.

The *Nauclea cadamba* (or kuddum), a fine shady forest tree, bearing in July a profusion of soft buff-colored sweet-scented flowers, perfectly globular in shape and of the size of a tennis ball—a charming road-side tree.

Swietenia mahogani, or mahogany tree, is an exceedingly handsome and valuable timber tree, but of slow growth.

The *Melia sempervirens* (or bukayûn), a rather handsome tree, with ash-like foliage and elegant lilac-scented flowers.

The *Jonesia asôca* (asôc), one of the most gorgeous and beautiful objects of the vegetable world when in full bloom, with its large compact trusses of orange and scarlet. Flowers in February and March, and again occasionally in June or July, but not to the same extent. Gives a thick heavy shade, and when out of blossom is still ornamental from the graceful droop of its foliage and the numerous pendant, India-rubber like leaflets, of various shades of purple and bronze.

The *Mimusops elengi* (or bokul), a very fine timber tree, bearing, in March and up to July, small spurrewel-shaped fragrant flowers, a great favorite with the Bengalis, and deservedly so. There is no finer object than a handsome well-grown avenue of bokul trees, such as one existed a few years ago on the western bank of Tolly's Nullah, near Tallygunj, as an approach to the handsome group of temples, or *Thakoorbattee*, erected by the Munduls of Bhowally, and dedicated to the God Radhakrishna. The owners having become involved in debt, this noble avenue, the finest I have ever seen, was ruthlessly cut down and sold for timber by a grasping decree-holder.

Kigelia pinnata, a large somewhat coarse-foliaged tree, with very remarkable rope-like woody flower stems which hang from the branches to a length of ten feet till they nearly touch the ground, and bear a succession of handsome, deep *sang-de-bœuf* colored flowers, which give forth at night a somewhat unpleasant smell.

The *Grevilla robusta*, a very beautiful pyramidal tree, with dense fern-like foliage.

The *Ficus elastica* (India-rubber tree), *Ficus Indica* (bâr), and *Ficus religiosa* (pipal), are all useful shade-trees for road-sides.

The *Casuarina muricata* and the *Uvaria longifolia*, or *Debdaru*, are too well known to need description.

Of the fruit trees the following may be enumerated:

The *Mangifera Indica*, or mango (ám); the *Artocarpus integrifolius*, jack-fruit (kûntal); the *Tamarindus Indica*, tamarind (tentool); the *Adansonia digitata* (Baobab), monkey bread fruit or bilaetee tentool; the *Dellenia speciosa* (châлта); the *Diosperos kaki* (bilaetee gab); the

Jambosa vulgaris, roseapple (or gûlab jam); the *Jambosa alba*, starapple (or jumrool); the *Terminalia catappa*, Indian almond (or dêsee badam).

The following are amongst the most useful timber trees :—

Melia azad (Neem)—A hardy and quick-growing tree, much prized by the natives for its medicinal qualities. Yields an useful fragrant wood for household purposes, the heart wood much resembling mahogany.

Tectona grandis (Sagoon, teak)—A large forest tree, yielding a valuable wood, but of very slow growth.

Acacia sirisa (Siriss)—A rapidly growing tree with a coarse-grained timber of little value; used principally for box planks.

Nuchelia champacca (Champa, Sampangi)—A small tree, prized by the natives of Bengal for its large narrow-petalled flowers of a dull yellow color and delicious fragrance, and which are used in religious ceremonies. The wood is of a rich brown color, close-grained, finely mottled, takes a fine polish, and makes beautiful furniture.

Acacia, catechu (Shah)—A large tree, with bipinnate foliage, yields the *cutch* of commerce. Timber considered more durable than teak; used for posts, rafters, spear-shafts, &c.

Dalbergia sissoo (Sisu or Sissoo)—A handsome and useful timber, strong and durable, with a close compact grain; suitable for all kinds of joiner's and carpenter's work.

Inga dulcis, a very fast-growing tree, with a very tough, hard, heavy, close-grained wood, very like ash.

Lagerstroemia regina (Jarool)—A splendid tree, with

rich rose-colored, or occasionally purple, blossoms. The timber is most useful for all purposes, house-building, planks, scantlings, boat-building, &c.

Erythrina Indica (Pahta Mundur *Kashi*)—A moderate sized tree, very common; bears in March clusters of brilliant scarlet flowers, but of no beauty at other times; yields a strong wood, useful for floor or wall-planking, but of no great scantling.

Feronia elephantum (Kuthbêl)—Grows to a good size; good timber, close and even-grained; used for doors and rafters in native houses.

Artocarpus integrifolius (Kuntal, jack)—Yields a handsome wood for furniture-making, also for ghannees or native oil-mills.

Grislea tomentosa (Kardahi, Dharee dhao)—A small tree with drooping branches. A mass of dazzling red when in flower in February and March; wood strong, close-grained, and heavy; useful for posts and tie-beams when procurable of sufficient size; is easily established and a rapid grower.

Ficus guleria (Goolar)—A common, coarse, fast-growing tree, with a coarse grained brittle wood; only useful for one purpose, well-curbs or foundations for steps, as it does not decay under water.

Nauclea cadamba (Kuddum)—Gives a wood of close and even grain, but brittle and wanting in strength.

Swietenia mahagoni (Mahogany)—Too well known to need description.

Bombax heptaphyllum (Simul)—A tree of very rapid growth, bearing a gorgeous crimson flower, succeeded by pods full of silky cotton; the wood is light and coarse, but planks cut from old trees make good boxes.

The following are suitable for planting on waste land and burial-grounds :—

The *Dalbergia* (Sissoo)—This common tree of the Indian jungles grows fast, and has a capital wood, useful for many purposes.

The Rain tree *Guango* (*Pithecolobium Saman*)—A very fast grower; gives splendid shade, and yields a pod with a sweet pulp, which is greedily eaten by cattle, but gives a timber of little value except as fuel. Any of the smaller fruit trees are also suitable, such as the *Psidium guajava*, guava (pyara or amrood); the *Achras sapota*, sapota (supattoo); the *Zizyphus jujuba* (bâer) kool; *Zizyphus vulgaris*, plum (koolphul); and many others. No plant is more useful in this respect than the *Musa sapientum*, the plantain (kela), of which there are several good kinds, the best being the champa, chinee-champa, martaban, Daccaé.

The above list is in no way intended to be exhaustive, as I have simply given the names of those trees with which I am myself best acquainted; many others will, doubtless, suggest themselves to the reader.

In planting trees by the sides of roads, a good sized circle or disc of turf should be removed from the spot selected. The earth should then be dug up to a depth of at least two feet, and if of a poor description, fresh earth, or preferably leaf-mould, should be substituted. The young tree planted in the centre of this must be protected by a stout basket from the ravages of cattle and goats, the latter especially are most destructive. Trees must be watered in the dry season, and their enclosure must be kept free from grass. No young plants will flourish if choked with *oolû* or *motu* grasses.

A good deal might be done to encourage the planting and preservation of trees on the road-sides by the adjacent householders, by offering a small premium for each tree planted and preserved in health-until it attains a certain height. This practice is followed in some of the States of the North American Union. Hindus also are always ready to plant and water *Ficus Indica* and *Ficus religiosa*.

CHAPTER XVI.

“It is but waste to bury them precious.”—*Chaucer.*

The manner of disposing of the bodies of the dead in this country varies greatly according to the religious customs of various creeds and castes. Christians, Jews, Mahomedans, Chinese, and some castes of the Hindus bury them in the earth; the Hindus in general burn them, or send them adrift in the sacred streams; and the Parsees or Zoroastrians expose them to the elements and to birds of prey in Towers of Silence.

The Christian, Jewish, and Chinese dead are usually buried in coffins; the Mahomedans and Hindus simply wrap in a winding sheet. Some castes of Hindus, such as the Boistums, are buried in an upright or sitting posture. The peculiarity of the Mahomedan mode of burial has been fully described in the chapter on Burial-grounds and need not be repeated.

The Hindu dead are cremated on the banks of the sacred Ganges, or where too remote to be carried thence, on the banks of some stream or tank, and except within municipal limits, where regulations are strictly enforced, the corpses of the poor are very generally sent adrift after a slight charring, or perhaps only touching the mouth with fire; and only a few years ago the number

of floating corpses, on which the foul carrion crows rode merrily over the waters of the Hooghly, was one of the sights for which Calcutta was famous or infamous. An old writer says: "Either from indolence or penury, the body is generally placed on a small hurdle, and when little more than scorched, is pushed off from the shore with a bamboo, there to float until it arrives at the ocean, unless it be previously picked up by a shark or alligator, or which is frequently the case, dragged ashore by pariah dogs and jackals and devoured by them in company with a numerous train of carrion birds of various descriptions. From one hundred to one hundred and fifty of these disgusting objects may be counted passing any one point in the course of a day, and in some places, where eddies prevail, a whole vortex of putrid corpses may be seen circling about for hours together. It was very common for us to be obliged "to clear the cable" occasionally of a human body speckled over by the partial separation of the cuticle and the *rete mucosum* from putrefaction."

I can well remember this state of things, and how, before the passing of the law forbidding the practice, and which is popularly known as *Beadon's Act*, the residents in the river-side villas at Garden Reach and from Cossipore to Barrackpore, had constantly to employ *domes*, or *murdafurashes*, to push off stranded bodies, and even to remove putrid corpses from under the open basements of the houses, where they were dragged during the night time by jackals and dogs, to the intense discomfort of the inmates of these otherwise delightful residences.

It would serve little purpose to enter into a con-

sideration of the relative merits of cremation and burial as a means of disposing of the dead in this country. The former is, as is well known, the common mode of disposal amongst the Hindus; but the sentimental and medical jurisprudential objections which stand in the way of the general adoption of cremation in European countries, would have equal force here as regards our Christian population, while there is a strong religious prejudice which would always prevent its adoption by our Mahomedan fellow-subjects. Cremation, as practised in this country by the Hindus, is however but little understood by Europeans, few of whom, though perhaps long residents in the country, have cared to investigate into the subject, and it is perhaps therefore not a matter of astonishment that we find even the latest and best writers on sanitation giving currency to such vague and incorrect statements as the following, which I quote from the "Treatise on Hygiene and Public Health, edited by Albert H. Buck, M.D., of New York," (1879), one of the latest, most complete and comprehensive popular works on sanitary subjects ever published.

"The list of nations in which cremation has been the customary way of disposing of the dead is a very long one, including the Greeks and Romans, many of the ancient tribes of Europe and Asia, and at the present day the East Indians and some Indian tribes in north and South America. In all these cases the body is burnt on a pyre in the open air, and the process is a very objectionable one, requiring, as it does, a long time for its accomplishment, an enormous mass of fuel, and creating an intolerable stench, which has to be smothered with the aroma of spices, where the relatives can afford

it. Moreover, the burning is often imperfectly done, the heat attainable in this way being insufficient to calcine the remains." (Vol. II, page 454.) Now this statement is so widely different from fact that it is plain the writer could have had no personal knowledge of the subject, and it is apt to create an unwarranted prejudice against a practice which, religious prejudices and sentimental objections apart, has every thing to recommend it. Now what are the actual facts as regards cremation as carried out at the established cremation ghats or grounds within municipalities in Bengal. I give them from intimate personal knowledge of the subject, there being from six to eight thousand bodies annually cremated at two burning ghats within my jurisdiction, and which I constantly visit. The quantity of fuel (ordinary soondry, gran, ban or other common fuel wood) required to completely consume the corpse of an average adult is from three to five maunds, or 240 to 400 lbs. The time required is from two to four hours, and the burning is so perfectly effected that nothing remains but a small pile of grey ashes, a small ball of contracted sinew about as big as a tennis ball and occasionally a few scraps of calcined bone, such as the ball of the great trochanter, or a small portion of the base of the cranium, while as for "the intolerable stench which has to be smothered in the aroma of spices," it is only the rich who indulge in sandal wood and the like, and that not from necessity, but from ostentation; and I may aver with truth, that though I have spent hours in watching the process, and have stood within a few feet of the burning pyres, that unless directly to leeward and in the way of the smoke, no offensive odour was percep-

tible. In fact there is but little to offend either sight or olfactories, the bodies are so folded up and hidden by the wood that there is little to be seen; and as to the smell there is hardly any perceptible at a short distance; and when the burning ground is surrounded with a high wall, the nuisance to the neighbourhood, if any, is reduced to a minimum. Dr. Parkes admits that 'the impurities in burning can be well diffused into the atmosphere at large, and would not add to it any perceptible impurity;' but *he* also appears to consider the expense an obstacle to its general adoption. Now the entire necessary cost of burning a Hindu corpse, including fuel, extras, the fee of the officiating priest or moripora brahmun, and the domes, or undertakers, is only Rs. 3-7 annas, or say six shillings. Compare this with the very cheapest form of funeral and charges for interment in any Christian burial-ground, and there can be little doubt as to the economy of cremation, while as to its superiority over burial in a sanitary point of view, there can be hardly a difference of opinion.

CHAPTER XVII.

"I feel that the question of the fitness of unsound meat for food is in such an unsettled state, that my action in the matter is often very uncertain, and I should like to have the question experimentally determined, for as it now stands we are either condemning large quantities of meat which may be eaten with safety, and are therefore confiscating property and lessening the supply of food, or we are permitting unwholesome meat to pass almost unchallenged in the public markets."—*Dr. Letheby*.

One of the principal duties of officers of health, or where there is no special health department, of the conservancy staff of a town, is to prevent the sale or consumption of unwholesome articles of human food,—that is to say, any flesh, fish, fowl, vegetables, corn, rice, bread or other food constituent, which is diseased, unsound, unwholesome, or unfit for the food of man.

It has been said, and with justice, "that a thorough practical knowledge of the qualities and appearances presented by the various articles of diet in their wholesome or unadulterated state, is a necessary qualification for the detection of unwholesome or adulterated specimens;" and I fear that that class of knowledge is one in which most conservancy officers in this country are very deficient, especially in the matter of meat. Still most natives of this country have a sufficiently intimate knowledge of the qualities of food grains and vegeta-

bles, to discriminate between what is good or bad. With regard to fish there can hardly be a mistake made, while as regards meat, even good authorities in England, such as Dr. Letheby, confess to doubts.

The most important staple of the food of the people of Bengal is *rice*. Of this grain there are numberless varieties, and, as a rule, unsound rice is seldom exposed for sale in the open markets. The greater portion of the rice is brought to market by boat, and accidents in the rivers and canals are of frequent occurrence. It often happens, therefore, and especially in the neighbourhood of Calcutta, that boats laden with rice are sunk in the channels, and some portion of the cargo is recovered after immersion for a longer or shorter time. In these cases, more particularly if the rice has been submerged in tidal or brackish water, it becomes sodden, decomposes, and is quite unfit for human consumption.

Rice is also occasionally damaged in large quantities by accidental fires, and by being drenched by the water poured over the burning buildings to extinguish the flames, the combined action of heat, smoke, and water rendering it quite unfit for food. Smaller quantities are also damaged by leaky buildings, damp storage, bad harvesting, &c.

Natives of the poorer classes will, however, readily buy such rice at a nominal price and use it for food. It is also purchased by the makers and vendors of the coarse inferior sweetmeats or cakes called malpowas and dall-puries, which are largely consumed by the poor and labouring class, and which are well known to cause diarrhoea and colic. Such rice should at once be taken charge of by the Conservancy or Health Department, and

submitted for examination to a medical officer. Where there are any large pig-feeders, like the Chinese hogslard manufacturers of the Calcutta suburbs, it may be sold to them under bond, but otherwise it should be buried in the nightsoil trenches as the only safe way of preventing its being used.

It may possibly be that, after only a short immersion in clean *fresh water*, the rice, if spread out to dry in the sun, may, though deteriorated in quality as a commercial staple, be not actually unwholesome; but this the medical officer will determine. In this view, however; every facility consistent with security against removal without permission should be given to the owners to spread it out in the sun and turn it over to dry, the object being to *prevent injury to the health of the people* and not to *confiscate property* or add to the already serious loss which has fallen upon the owner.

It is, as a rule, easy to distinguish fish which has become unfit for food. Fresh fish differ very much in appearance from those that have become stale or have begun to decompose. The gill should be bright and red, not muddy, pale or discolored; the flesh firm, stiff, and elastic. On pressing the finger into the flesh it should at once rise; if it remains dented in, or has a doughy pasty feel, the fish is stale and unwholesome.

But perhaps the sense of smell may be the most reliable guide: tainted or putrid fish cannot be mistaken.

Large quantities of chingrees in a putrid or semi-putrid condition are often exposed for sale in the markets. It is well known that the consumption of fish or shell fish in such a state not unfrequently produces serious intestinal disorders, and this is the more to be dreaded

in warm climates. There is no article of food in respect to which the lower orders are more reckless: they will eat fish in almost any stage of putridity. The Burmese and Siamese habitually eat rotten fish as a condiment under the name of gnapee and ballachong.

Even fresh fish and shellfish at certain seasons and with certain individuals produce serious illness. I have myself suffered from cholera from incautiously partaking of oysters out of season in Bombay, and at the present time two or three Bombay oysters, however fresh and good, in or out of season, are sufficient to produce violent choleraic symptoms. The same effect is produced on many persons from eating crabs and other crustaceans, and if the fish be at all decomposed, the effects are more marked and violent. The sanitary officer should never hesitate to seize and impound any fish which he finds in *any stage* of decomposition, always remembering that when that stage has *commenced*, every hour adds to its intensity.

There is a very considerable trade in dried fish, which is not only a source of nuisance to the neighbourhoods where they are stored, but which is a most unwholesome article of diet when partaken of, as it often happens to be, in a state of putridity. Natives, as a rule, cannot be brought to see this, and consider the seizure and destruction of such fish an arbitrary and unjustifiable proceeding. A few days before this page was written, some cart-loads of such fish were brought to me for examination, the greater portion of the mass was moist and putrid, swarming with maggots, grubs, and weevils, and the smell arising from it most offensive and sickening, still the owners would not admit that the fish

was in any degree offensive or unwholesome. It consisted of numerous kinds of freshwater fish, with a small admixture of the heads and tails of larger fishes, evidently the rejections of the market, but largely of small flat round fish, about the size of a rupee, and which when tilted into the trench for burial, looked like a heap of withered and decayed leaves.

A reference to the subject of unwholesome milk will be found under the head of *Cow byres*.

Meat is a much more difficult subject to deal with, especially with untrained native overseers and inspectors.

The following simple hints may be a guide to the judging of good or bad meat :

The muscle should be firm, but elastic, neither too pale nor too dark. When the flesh is pale and moist, it is an indication that the animal was diseased. The fat should be firm, white, and with no sign of hæmorrhage.

Yellowness of fat is not always a sign of unwholesomeness, as feeding on oil-cakes has a tendency to color the fat.

Any juice which exudes from the meat should be small in quantity, reddish in color. There should be no softening mucilaginous fluid or purulent matter in the cellular tissue lying between the muscles.

This tissue also softens, and is easily torn when stretched, if decomposition has commenced.

The odour of the meat should be only slight, fresh, and pleasant. When meat is suspicious, but shows no distinct outward sign of putrefaction, it may still be detected by thrusting a long clean knife deep into the flesh and smelling the blade. When meat is commencing to putrefy, it becomes pale, moist, doughy, smells sickly and offen-

sive, and gradually turns greenish ; after this stage no mistake can be made, and no further instructions are necessary. The consequences of eating diseased and unwholesome meat are somewhat uncertain. Parkes says, "Instances are not at all uncommon where persons, after eating presumed diseased meat, have been attacked with serious gastro-intestinal symptoms, vomiting, diarrhoea, and even cramp, followed in some cases by severe febrile symptoms. The whole complex of symptoms somewhat resemble cholera at first, and afterwards typhoid fever." On the other hand, it is well known that diseased meat has been largely eaten without producing any ill effects, and it is probable that the antiseptic power of thorough cooking may destroy the elements of parasitic disease.

The death returns of the suburbs, however, show that there is heavy mortality amongst the low classes of natives who habitually eat dead animals and diseased meat, such as the domes, mehters, chamars, and dosauds, the death-rate in 1879-80 ranging from 100 to 151 per 1,000.

Large quantities of tinned provisions are now imported into the country and sold by auction, and it often occurs that some portions of the consignments are damaged or *puffed* as it is termed in the trade. These are bought up and retailed by bazar dealers and up-country *boxwallas* or itinerant vendors. Sickness, diarrhoea, and colic are not unfrequently caused by using tinned or canned provisions, especially lobsters and other shell-fish : the only guide the inspecting officer has is the condition of the cans. If the heads or ends of the cans are concave, they are usually good and wholesome ; if, on the contrary,

the heads are convex, bulged out or 'puffed,' decomposition has commenced. If an awl or *brod* or sharp nail is driven through one end of the puffed can, the gas which is generally most offensive, will rush out with a noise like a steam escapement. Puffed cans should be confiscated and destroyed: they may do infinite mischief if sold, and their contents partaken of by the poorer classes of Europeans or Eurasians, the only people likely to purchase or consume them; *cheapness* being always a sore temptation to the poor, though, as a sequel, the cheapest bargains often prove the dearest in the end.

CHAPTER XVIII.

“ By a disinfectant is meant first a substance which destroys or renders inert that which produces disease, whether of an infectious or contagious type ; and secondly, a substance which arrests those putrefactive processes in decomposable material which foster or perhaps produce the germs, gases, and vapours that induce disease in the human organism.”—*Waller on Disinfectants.*

One of the disinfectants in most common use in the present day, is carbolic acid (Phenylic acid or coaltar kreosote). This is an oily liquid of active caustic properties, and is antiseptic in its action. It exists in the form of needlelike crystals, which liquify at a temperature of 93·20° Fahrenheit. It is prepared in various ways, but for commercial purposes it is distilled from the oil of coaltar. Naturally it is found in the urine of cows (Tidy), and if in their urine, it possibly exists in their dung. May not this be one reason for the reputed purifying and disinfecting properties possessed by the excremental products of the sacred cow.

Carbolic acid, whether in the form of solution or powder, is a most useful disinfectant. “ It is destructive of the low forms of animal and vegetable life, and arrests and prevents all kinds of putrefactive changes. (Wilson.)

Professor R. V. Tuson, Royal College of Veterinary Surgeons, London, has lately recommended an improved

disinfectant consisting of carbolic acid saturated with sulphurous acid: its composition is sufficient to show that it must be a most useful disinfecting agent. A similar combination was some years ago proposed by Professor Abel.

Calvert's carbolic powder is a convenient dry form in which it is procurable at any chemist's.

The acid (Calvert's) costs in London about four shillings a gallon.

Carbolic acid is usefully employed in conjunction with the iron salts, as well as mixed with slaked lime. In the latter combination I have used it extensively for disinfecting latrine seats and drains.

For liquid matters, such as the contents of cess-pools, drains, privy-wells, and slaughter-house reservoirs, four pounds of Ferrous sulphate, or two to three pints of strong solution of perchloride of iron, with two ounces of pure carbolic acid, dissolved in a gallon of water, will be found useful; for disinfecting heaps of solid manure, or other offensive matter in bulk, five to six gallons of water may be added, and the solution distributed through the rose of an ordinary garden watering can.

Carbolic acid in its pure concentrated state is an active caustic destroying the skin. If it unfortunately comes in contact with the hand, the best remedy is olive or other sweet oil. Taken internally, it is a violent poison: olive oil is in this case also the best antidote. A very pleasant and useful deodorant is formed by the admixture of equal parts of carbolic acid and camphor. This mixture dissolved in water may be employed in cases of domestic sickness, for disinfecting utensils, bathroom drain pipes, and the air of sick-rooms.

Macdougall's powder is a carbolate of lime and magnesia. It is one of the first and best disinfectants for sewage, privies, cess-pools, and excreta pails. It is sold in casks by the cwt., and is an economical agent when a deodorant is required for use in large quantities.

Sulphurous anhydride or sulphurous acid gas is one of the simplest and most powerful agents for disinfecting the impure air of hospitals, sick-rooms, dead-houses, privy-vaults, and even the open air where foul odours arise from the decomposition of deposits of street refuse in ponds and tanks. It decomposes sulphuretted hydrogen, acts powerfully upon organic matters, and completely disinfects miasms (Parkes). It is produced by burning sulphur in the presence of oxygen.

Chloride of lime, the bleaching powder of commerce, prepared by impregnating lime in a dry state with chlorine is a well known and valuable disinfectant for drains and cess-pools, but for use on a large scale is too expensive.

Quick-lime is useful for public latrine-drains and for open drains into which sewage flows, but its effects are neither thorough nor lasting. It may be better described as a detergent than a deodorant.

Ferrous sulphate (copperas or green vitriol) or protosulphate of iron has been recommended for disinfecting heaps of dung, foul cess-pools, and the like. It is easily prepared, the crude material being obtainable in the bazar. It is prepared by spreading it out on a floor in the open air, watering it, and turning it over till completely oxidated. Its beneficial action is, however, somewhat doubtful.

Ferric chloride (Perchloride of iron) is next in usefulness to Macdougall's powder. It is prepared by mixing

equivalent proportions of common salt, iron rust, sulphuric acid, and water. When used as a disinfectant, it yields chlorine to organic matter, becoming itself reduced to ferrous chloride (Tidy). It acts both on sulphuretted hydrogen and on sulphide of ammonium. It contains a small proportion of arsenic (Parkes).

The cost of manufacture is about twenty-five rupees a ton.

Nitrate of lead (Plumbic nitrate) has recently been recommended, dissolved in water with the addition of common salt, but I have not discovered that it has any effect in deodorizing either urine or fæces.

Chloralum is a much advertised and belauded preparation for disinfecting purposes. It is simply a chloride of aluminum, useful as an antiseptic, but with little disinfecting power compared to the zinc and iron salts.

Alum is useful for precipitating the impurities in stagnant pools or liquid sewage, with the after addition of milk of lime or cream of lime as it is sometimes called.

The salts of copper are powerful disinfectants, but their expense is against their general use. The usual form is the sulphate of copper or blue vitriol.

The waste solutions from telegraphic batteries may be usefully employed for disinfecting purposes, their action being aided by the copper compounds which they contain to a small extent.

Among the more simple disinfectants suited for domestic use may be mentioned roasted coffee. The way of using it is to dry the raw bean, then pound it in a mortar, and roast it on a heated iron plate or a hot fire shovel until of a dark color. The smell is pleasant and refreshing.

CHAPTER XIX.

“Houses are built to live in, not to look on; therefore let use be preferred before uniformity, except where both may be had.”—*Lord Bacon.*

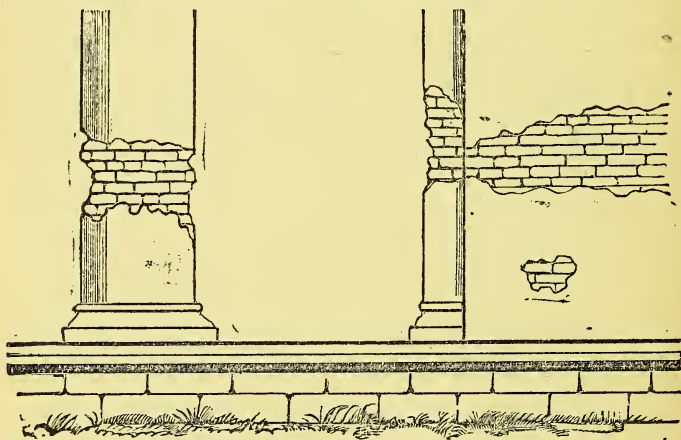
In Lower Bengal all houses, however well raised from the ground, are more or less damp in the rains.

Even in the best built European dwellings, raised on arches, it may be five to six feet from foundation level, the unmistakable *damp line* makes its appearance both on the outer and inner walls as soon as the rains have lasted long enough to saturate the subsoil on which the foundations rest. This is owing to the clay soil which retains moisture even in well-drained localities, and to the materials of which our houses are constructed being of a spongy and absorbent nature. The hardest and best burnt brick will absorb one-sixteenth of its weight of water, and the softer and more porous the brick, the greater quantity will it drink up.

The brickwork, therefore, being in immediate contact with the wet subsoil, the damp rises in the walls by capillary attraction until it reaches the line of evaporation. As both the soil and the materials of buildings are often saturated with nitrous salts, the latter crystallise as the moisture evaporates, and their bulk being thus increased, they burst the pores in which they are contained and the

disintegrated plaster and brick crumble away, causing that unsightly desquamation and dilapidation so common in the basement walls of ordinary buildings and especially in inferior native houses.

It will be observed that this crumbling away does not take place at the foot of the walls or pillars, but at some distance from the ground, and that if the lower part be protected by a coating of Portland cement, the line of evaporation and erosion only mounts higher, but this deteriorative action is not prevented from taking place. The extent to which this disfiguration, and ultimate ruin



EFFECTS OF NITROUS EFFLORATION ON BUILDINGS

of buildings, goes, is shown by the above sketch, which represents the state of many buildings familiar to every resident in a Lower Bengal town. This state of things is due either to ignorance or heedlessness on the part of the builders in neglecting during the construction to insert a *damp-proof material* as the last course of the

plinth. Several plans have been tried with more or less success to prevent damp from rising in the walls, and to remedy or hide it when present, and the lower stories of many otherwise comfortable houses are rendered uninhabitable or unsightly from failure to accomplish this. Portland cement plastering, high dados of dark coloured silicate paints have all been tried, but still the nitrous efflorescence appears, and the damp line mounts higher and higher till it can escape into the air by evaporation. Silicate paint, though better than the ordinary paints, is inefficacious where there is much nitre in the walls. The following, which is a Russian recipe, may be tried with advantage: Make a boiling solution of two seers of green vitriol (or copperas) to fifty seers of water, or about twelve gallons; add one seer white resin, five seers of sifted red or yellow ochre, four seers of rye meal (or coarse country flour), and three and-a-half seers of linseed oil; stir the whole together till the ingredients are thoroughly incorporated, and apply two coats while hot, allowing the first to dry before applying the second. The mixture must be applied in dry weather while the walls are free from damp: a coat of silicate paint of any desired color may be afterwards applied. Complete prevention, however, is only applicable at the time of construction, and it is effected by the insertion of a damp-proof course or a layer of some non-absorbent impervious material or composition between the foundation and superstructure. Various substances have been used or suggested for this purpose. Sheet-lead or sheet-copper would perhaps be the best materials, being indestructible, perfectly impervious to damp, and neither apt to break nor crack beneath superincumbent and unequal pressure, but

their expense is quite against their general use. I once knew a case where a German engineer, in charge of buildings near Calcutta, put sheets of plate glass in the wall of a building as a damp-proof layer, I fear without much success, as the unequal settlement of the building and the weight of the superstructure must have reduced it to fragments. In those days De la Bastie's process of toughening glass was not known, and it may now be well worth ascertaining whether toughened glass tiles or slabs manufactured from blast furnace slag by De la Bastie's or Siemen's process, might not be introduced into buildings for damp-proof courses with every prospect of success; as if the glass thus produced is sufficiently tough for railway sleepers, it would surely be quite capable of bearing the inert pressure of the weight of a building. Slag bricks, enamelled bricks, and vitrified stone-ware perforated tiles, as recommended by Eassie, are also now manufactured. The material most commonly used in this country is Seyssel Asphalte, but it has several disadvantages, the principal being its aptitude to soften at a high temperature and its compressibility, the great pressure of the superstructure squeezing and forcing the yielding material from between the joints which interferes with its successful action as a damp preventer, and the superstructure of buildings has even been known to slip from the softening of the asphalte in hot weather. An useful but little known composition for the purpose is a mixture of fresh slaked lime and vegetable oil. This must be well mixed by hand the day before it is wanted for use. It is then to be spread evenly over the foundation course with a trowel in a layer about three-quarters of an inch thick, and after it has been left for a day

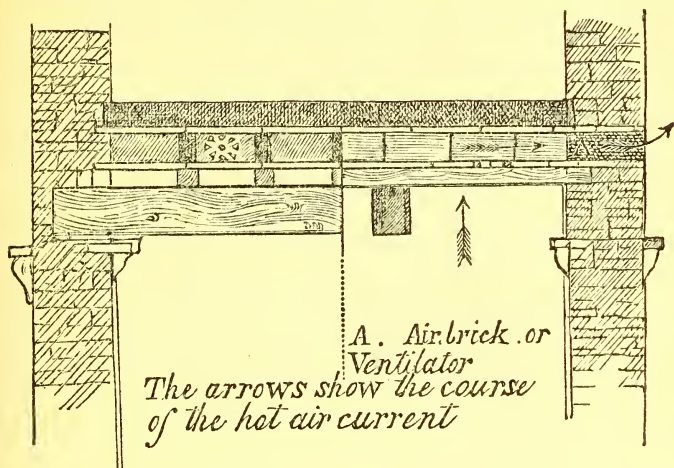
or so to set firm, the building may proceed, care being taken in laying the first courses of brick not to break up or disturb the cement. A damp-proof course may also be laid with bricks, which, after being heated, have been plunged into a bath of boiling coaltar and then rolled in dry sand. It will add little to the first cost, but greatly to the stability and good appearance of houses generally, if the basements are plastered with Portland cement instead of the ordinary sand plaster; and the extended manufacture of cement in this country, especially by the Indian Cement Company, will tend to bring the material into more general use. Damp houses can never be healthy houses, moisture being a necessary factor in the process of decomposition of organic matters in the soil, which give rise to malaria and consequent danger to health. A house built on a damp site, without a damp-proof course, and with walls often of insufficient thickness, exposed to heavy driving rains, lasting as they sometimes do in the tropics for days together, cannot fail to be unhealthy; the damp is absorbed by the walls and given off in vapour inside the rooms. Thus during the rains in Bengal we find our boots, books, and everything made of leather covered with green mould, and falling to pieces, while clothes refuse to dry, and all our surroundings feel damp and clammy. Pictures hung against the walls become irretrievably ruined, and every piece of furniture or cabinet-work with glued joints falls asunder.

Every house should be surrounded with a well-constructed stone or brick drain, well cemented with Portland cement, to carry off the water streaming down the outer walls and which would otherwise lodge about the

basement and soak into the foundations. There should always be a space of ten or twelve feet round the house either paved, tiled, or laid with a good layer of jhama or stone well consolidated and sloped from the basement and nicely gravelled. Grass should never be allowed up to the walls. A belt of sharp gravel is also a great obstacle to snakes, which are too apt to find their way into our Indian houses.

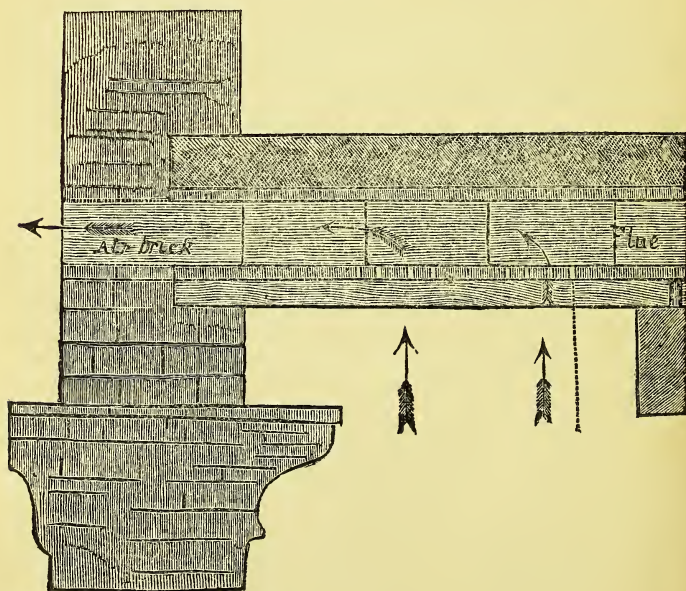
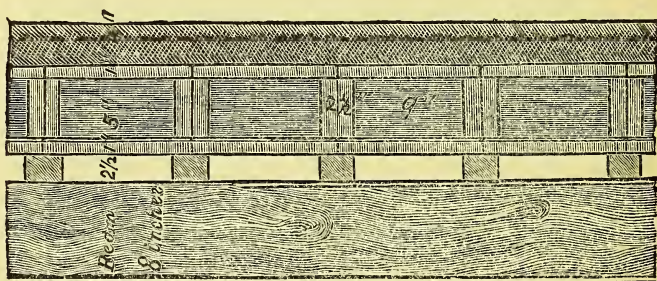
Moisture and heat being the two most essential elements in the process of organic decomposition, the next desideratum of our Indian dwellinghouses, after the prevention of damp, is to keep the temperature as low as possible. Single storied, or what are called lower-roomed houses with flat terraced roofs are often unbearably hot. Terraced roofs are usually constructed with beams, rafters, and a double layer of tiles; the upper layer imbedded in mortar and placed diagonally, so as to break joint with the lower, and from five to eight inches of concrete beaten and plastered. In some of the older houses a depth of even ten to twelve inches of material will be found, evidently put on with the intention of opposing a greater obstruction to the sun's rays. A roof of this kind is, of course, very weighty, and necessarily requires stout walls and timbers of considerable scantling for its support; and in the older houses alluded to, very considerable deflection of the beams may be observed. I have recently constructed an improved form of terraced roof or floor, which, while it has all the strength, rigidity, and stability of the ordinary form, possesses three important advantages, *viz.*, greater depth or thickness with comparative lightness, economy of material, greater resistance to the heat of the sun, and complete ventilation.

Over the ordinary beams and burgahs (rafters) the



first course of tiles is laid as usual, a row of table-moulded bricks is laid on edge in mortar over the longitudinal join, and the second layer of tiles is then laid with mortar, thus leaving flues or spaces of nine inches by five as shown in the following sketch. Four inches of finely broken khoah is then spread as before, mixed with a sufficient quantity of good fresh lime, well turned over, incorporated, beaten, and finished off in the usual manner. We have thus nearly double the depth of the ordinary roof with less weight, and the air spaces not only interpose a stratum of air and prevent radiation of heat as in the case of the solid terrace, but by the use of air bricks or ventilators at the ends of the flues, and perforated tiles in the lower layer or ceiling, perfect ventilation and escape of hot air from the upper part of the room is secured, and the temperature correspondingly reduced. There can be no reasonable doubt as to

the stability and durability of a roof so constructed, for I have had a floor constructed on this plan, over which there is constant daily passing to and fro, and over



which the whole of the heavy furniture of the upstairs rooms, including heavy almirahs, requiring ten or twelve men to lift them, has been carried without in the least affecting it.

Doubts were expressed by several practical builders and engineers at the time of construction as to whether this floor would stand, or even bear the concussion of the beaters while consolidating the concrete, but the result has proved these fears to be groundless. Where iron can be procured, a more durable form of this roof would be to substitute iron girders and inverted **T** iron for the timber beams and rafters, the tiles resting on the flanges of the inverted **L** irons. Another advantage of this form of construction is, that the ceiling between the girder beams can be plastered smooth and flush with the under-surface of the **L** iron, and will thus give more scope for ornamentation if desired. There is in many other directions great room for improvement both in the plan and construction of our Indian dwellings, and which, if followed, would add not only to our comfort and enjoyment, but to the preservation of health. Little attention has been paid in the first instance to the requirements of a tropical climate, and house builders have gone on from generation to generation building upon the same lines and following the same models as their predecessors. As far as appearance is concerned, there seems to have been little attempt at æsthetic treatment of private dwellings, and in short, if, as a well-known writer on architecture says, "architecture is building with something more in view than mere utility and convenience, *it is* building in such a manner as to delight the eye by beauty of form, to captivate the imagination, and to satisfy that faculty

of the mind which we denominate taste;" then it is evident that architecture had nothing to do with the construction of the hideous square four-sided, equally divided buildings in which Anglo-Indians seem, as a rule, content to pass the best part of their lives.

The object of this work, however, is not to descant upon æsthetics beyond this point, that beautiful surroundings by adding to contentment and happiness, are undoubted aids in preserving that '*mens sana in corpore sano*,' which is essential to our well being. With regard to the construction of our Indian dwellings, it has often been a matter of wonder to me that English settlers in this country have not taken a lesson from the people of the sunny lands of the south of Europe, or from the Syrians, Egyptians, and other eastern nations, and built their dwellings with an open central court, thereby admitting light and air to the very heart of their habitation.

I cannot claim this idea as an original one, for I have quite recently, whilst employed on these pages, come across a similar suggestion made as far back as 1863 by that excellent authority on such subjects, Colonel J. G. Medley, R. E., late Principal of the Roorkee College and Editor of the Professional Papers on Indian Engineering; but I believe I may fairly claim to be the first who has not only independently arrived at the same idea, but has, to use his words, "worked the idea into a tangible shape." The room in which I am now writing looks into just such a court as Colonel Medley has suggested in the following extract,—“In many parts of the country perhaps the old eastern style of building round an open quadrangle in the centre might be adopted with advan-

tage. This open court paved with marble or stone, filled with fragrant shrubs, and with a fountain and tank in the centre." My court has no fountain at present, there being no regular water-supply, and all fountains which depend upon a tank filled by the blistry, are to my mind but a delusion and a snare ; but it is enlivened and made fragrant and healthful by many-hued and sweet-scented shrubs and plants, and is shaded by an ornamental verandah or sunshade on all four sides. The rooms being built around it, every room in the house opens to the open air on *both* sides, and as the sun in his diurnal passage from east to west only shines directly into the court for a short period of the day, whilst every current of air finds its way into it, the house is cool and pleasant at all times. I may remark that the house was not newly built on this plan, but the opportunity of restoring a very large and somewhat ruinous house was taken, and the centre portion entirely removed and converted into the court, and a residence in the house throughout the three seasons has proved its complete suitability to the climate.

There can be no doubt that in damp and badly drained localities the health of the people would be better if their habitations were well raised from the ground, so as to remove them from immediate contact with the subsoil, and permit the air to permeate freely underneath them. This is recognised by tea-planters and others who settle in malarious and jungly districts, and is adopted with great advantage by nearly all the agencies for deportation of emigrant coolies.

It is hopeless to expect that the people will ever be induced to depart from their old plan of hut-building,

but local authorities who may have to hut coolies or nightmen or other employés might follow this plan with advantage, and there can be no doubt that the extra cost of construction will be more than repaid by the increased healthiness of their workmen, and consequent gain in the amount of work obtained from them.

When huts are so raised from the ground, however, they must be sufficiently high to admit of any dirt or rubbish that may gather under them being cleared away, and the space below the floor must neither be allowed to become a deposit for garbage or to accumulate stagnant water.

Huts so built may be floored either with split bamboos, or with *jarool* planks. The ordinary dwellings of the poorer classes of Bengal are constructed chiefly of bamboo framework with timber posts, either sâl-wood (*Shorea robusta*), soondri (*Heritiera littoralis*), or goran (*Ceriops roxburghianus* or *Rizophora decandra*) with a roof of tiles or thatch of paddy straw, ooloo-grass (*Sacharum thunbergi*), or goleputta (*Nipa fruticans*). The latter is much used in the neighbourhood of Calcutta, being brought in great quantities from the Sunderbunds, in some parts of which it grows in great profusion, and regarding which Dr. Hunter, the Statistician of Bengal, has fallen into a curious error, as he states this to be the leaf of the hental (*Phoenix paludosa*), known in the Sunderbunds as hurtal, hental, or bokra. The latter is a species of wild saltwater date, the fruit of which is a favorite food of the rhinoceros, and the pith of which is eaten by the wild pigs, and occasionally under pressure of hunger by boatmen, but the stiff prickly leaf of which is most unsuited for thatching

purposes, as would be evident to any one who tried to force himself through a patch of hental jungle or 'bokra-bon,' as I have often had occasion to do in pursuit of game.

Grass, straw, and goleputta roofs become extremely inflammable in the hot weather, and for this reason laws and bylaws have been enacted to prohibit their erection in towns, and it is no doubt the duty of local authorities to discourage them in every way in populous localities. As a question of comfort and hygiene, however, I consider the goleputta or any thatched roof far superior in every way to one of tiles. In the first place, it is *less costly*; secondly, it is much cooler in the summer, more watertight in the rains, and warmer in the cold weather. True, it is more inflammable, and in this respect there is an element of danger; on the other hand, an occasional fire is a great *purifier*, and as the hut-owner has seldom any heavy property to remove, and there is, as a rule, little danger to life, I am not sure that the balance is not on the whole in favor of inflammable constructions (in thinly populated neighbourhoods and situations remote from other valuable buildings or property always understood).

However unfavorable to public health such a result may prove to be, we must accept the fact that one of the inevitable consequences of the spread of civilisation and increase of prosperity in any country is the aggregation of a large portion of their inhabitants in towns. And in all the problems we have to consider for the sanitary improvement of our towns, we must constantly keep in mind the fact, that the evils attendant upon overcrowding and the aggregation of large numbers of

people within an urban area, will continually increase with the growth of the population. In all our plans for improvement, therefore, we must not only bear in mind the actual wants of the present, but the probable necessities of the future. These points should be especially considered when remodelling old bustees and mohallas, as well as in laying out new quarters and extensions. It is mainly by their utter disregard to future requirements that the predecessors of the local authorities of the present day have left their successors such a fearful legacy of intricacy, disease, danger, and filth, as exists in the crowded mohallas and paras, the narrow tortuous gullies and lanes, and the reeking cess-pits and filth-sodden soil of the majority of native towns: for one of the greatest difficulties in the way of municipal improvement in this country is the irregularity with which the streets and lanes are laid out, most towns presenting a perfect labyrinth of tortuous lanes, bylanes, and gullies, clearly showing that their arrangement has been a matter of chance, following the necessities of the time being, without any respect to the public convenience or the future of the townships.

The following description by Mackintosh of the native town of Calcutta, in 1780, is very characteristic of the condition of many native towns even at the present day:—
“ From the western extremity of California to the eastern coast of Japan there is not a spot where judgment, taste, decency, and convenience are so grossly insulted as in that scattered and confused chaos of houses, huts, sheds, streets, lanes, alleys, windings, gutters, sinks, and tanks which jumbled into an undistinguishable mass of filth and corruption, equally offensive to human sense and

health, compose the capital of the English Company's Government in India."*

Not only does such an arrangement largely contribute to the general insanitary condition of our towns from the imperfect perflation of air, and the impossibility of carrying out proper scavenging, but in cases of conflagration it adds greatly to the rapid spread of the fire and to the difficulties in the way of checking its ravages and its advance. Where the houses occupying these confused areas are constructed, as is usually the case in Bengal, of most combustible material, which, after baking in the torrid heat of the summer sun, becomes as dry and inflammable as tinder, the fire spreads with a rapidity that is most appalling, the heat from the blazing huts creating a vacuum, which on the stillest day generates an air current, which in its turn drives the flame forward with increased fierceness. Everyone who has assisted at such a conflagration will understand the powerlessness of even steam fire-engines, and that the only means of effectually checking the advance of the fire is to pull down the huts in a wide gap, and so cut off the communication with the rest of the town.

This, when the streets are straight and wide, is easily effected; but where, as is too often the case, the crowded masses of huts and houses are intersected only by narrow winding lanes and gullies, is almost an impossibility. Torrents of sparks rain on the dry leaf or grass roofs, blazing bamboos propelled by the steam generated in the hollow stems are projected like rockets into the air, and the flames leap from hut to hut with uncontrollable

* Census Report, by H. Beverley, C. S.

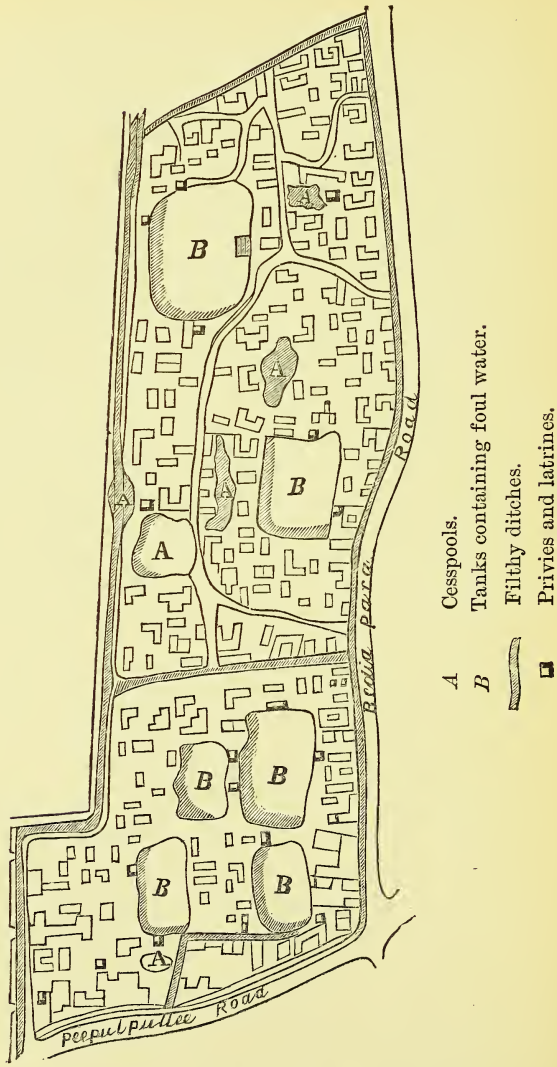
rapidity. The heat and smoke become insupportable such as not even trained firemen can face, and I have seen the men of the European fire-brigade of Calcutta fairly driven from the hose of a steam fire-engine and obliged to abandon it in the midst of the flames, it being impossible to extricate it before the fire was upon them. On this occasion the flames devoured everything before them till they reached a broad street, where they died out simply from want of further fuel.

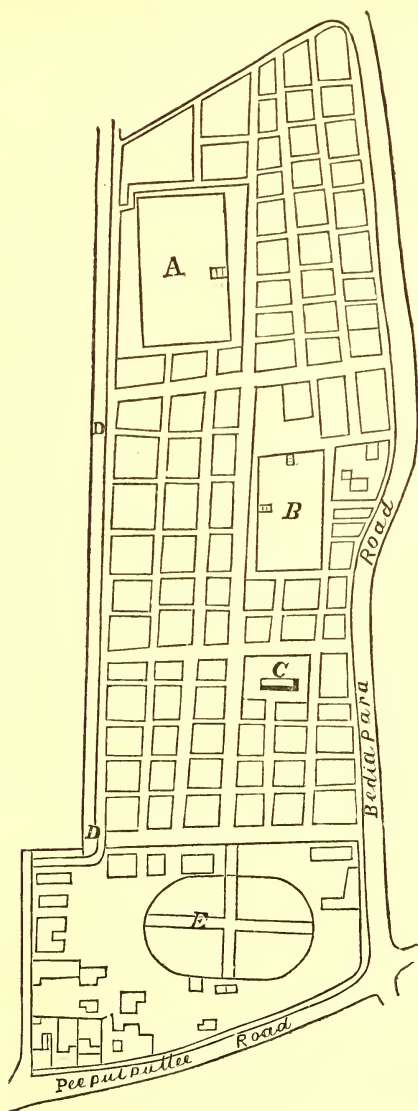
It is a curious thing that these great fires in our native towns appear epidemically. During one hot season hardly a single large fire will occur; the next, village after village, mohulla after mohulla, will be swept away. It is difficult sometimes to account for these occurrences; they probably originate in the majority of cases from accident or carelessness, but they are not unfrequently, whether rightly or not, attributed to the ghuramee, or thatcher class, who are supposed to act the part of the incendiary to obtain work; and in cases which have come under my notice there could be little doubt on the subject, rags soaked in kerosine oil having been found in the thatch of a hut. The ghuramee is popularly believed to impress the crows into his service in carrying out his nefarious designs; a piece of smouldering tinder being attached to a bit of flesh, which is then thrown to the crows, who seize the tempting morsel, and flying off with it, drop it, the chances being ten to one that it falls on the roof of a thatched hut and sets it in a blaze.

It will thus be apparent that there can be no real security for life and property unless wide straight streets and roads are constructed, so as to intersect the bustees and mohullas at convenient intervals. These streets should,

as far as possible, run in parallel lines and the cross streets should intersect the others at right angles, advantage being taken of large public tanks to construct squares. The municipal or local authority should always take advantage of the clearance effected by periodical conflagrations to control the rebuilding of the houses and huts, and to remodel the bustees, securing them by the construction of roads and cross lanes, the proper arrangement of the huts, and the prohibition of inflammable walls and roofs from future risks from fire; and providing for proper ventilation, thorough scavenging, and sanitary supervision. The plans given on the next page give a good example of the vast improvement that may be effected in this direction; they represent the past and present state of one of the *bustees* in the suburbs of Calcutta. The huts which were formerly constructed with mat walls and goleputta roofs of all shapes, sizes, and elevations are now replaced by neat compact houses with white-washed mud walls and red tiled roofs, at the same elevation throughout. The huts are six feet apart from wall to wall, and three feet from eave to eave: between each row is a footpath nine feet wide, while the main roads are sixteen feet in width and are metalled.

The floors of all huts are well raised, the material for floors and walls being taken from the spoil earth from the re-excavation of the tanks kept for drinking and bathing, several filthy useless tanks having been filled in with refuse, and the material obtained by levelling the whole space occupied by the old bustee before its reconstruction. A fire-engine can have access to any part of this bustee, and from the arrangement of the houses and their construction, the risk from fire has been reduced to a minimum.





- A* Bathing tank.
- B* Tank for domestic uses.
- C* Public latrines.
- DD* Road over covered sewer.
- E* Intended site for a garden.

In every municipality or station we may presume that there is something in the shape of a fire-brigade, or at least some appliances at the disposal of the Municipal authority, the Magistrate, or the Police authorities, for the extinction and controlling of fire, and if there is not any organised establishment, there certainly ought to be. Even in our larger towns, however, the means at the command of the local authority have seldom been in any way efficient, and what I have myself noticed as being a great want on the occurrence of serious fire, even when an European brigade has been present, has been the want of sufficient appliances for cutting down and removing inflammable roofs and walls in order to cut off and confine the fire to a certain area, *viz.*, light sharp axes, tomahawks and bills, as well as pole-hooks and drag-hooks and chains. These are of greater importance even than fire-engines and hose in the case of bustee fires. To play upon a blazing hut even with the steam-engine, is, as a rule, a waste of time, labor, and water; the thing to be done is to pull down and remove the huts in the track of the advancing flames, and to saturate the roofs of the huts in front of the fire so as to prevent them, if possible, from catching.

CHAPTER XX.

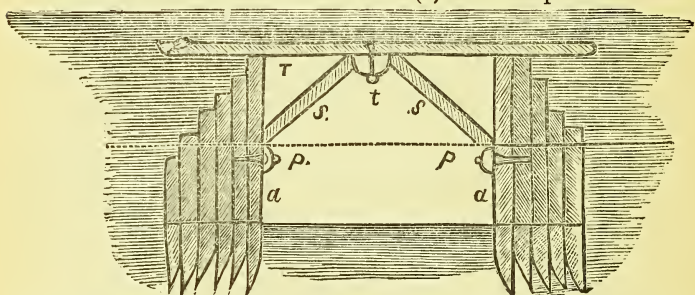
“A smooth, firm, dry road is one of the greatest conveniences and enjoyments, while a rough, soft, muddy road is one of the greatest drawbacks and annoyances of country life. Bad roads form the greatest obstacles to progress and permanent improvements in all the neighbourhoods that are blasted with their presence; they have a demoralising effect upon the inhabitants, and are a sure sign either of poverty or mismanagement, or both.”—*American State Report*.

Roads in Bengal are of two kinds—cutcha, or fair weather roads, and pucka, or metalled roads. The cutcha road is simply a track more or less raised and drained, formed on the natural soil of the district, and unless in gravelly or sandy soils, is hardly passable in the rainy season.

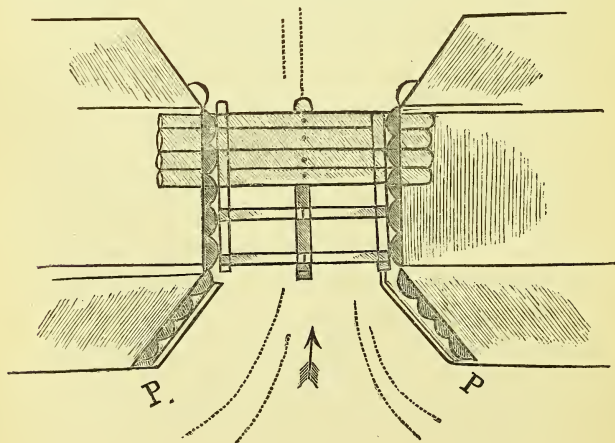
Pucka roads in Lower Bengal are again divided into stone or Macadamised roads and jhama roads, or roads metalled with jhama khoa, or broken vitrified brick. Higher up the country, roads are made with kunker (nodular limestone) or quartz pebbles.

In making cutcha roads on alluvial soil, nothing can be done beyond raising the surface of the road sufficiently to prevent its being under water during the rains, and providing side ditches or drains with sufficient fall to carry off the water and prevent the saturation of the subsoil. Culverts or waterways must also be provided to allow the drainage of the country to follow its natural inclination, and so prevent the road embankment from being breached. Where masonry structures cannot be afforded, very efficient bridges may be constructed of tál trees or other indigenous timber, as

shown in the figure below. This is formed by a row of sheet-piles formed of t \hat{a} l trunks (a a) split in half, pointed at the lower ends, and driven down below the bed of the watercourse. A plate (p) is then bolted or spiked along them, a similar piece (t) being bolted to the underside of the bridge timbers (T), and struts (ss) fixed in the manner shown at (t). The piles should



be continued in the form of a wing-wall on the upper side of the bridge to prevent the water cutting away behind it as shown at (PP). The banks should always be

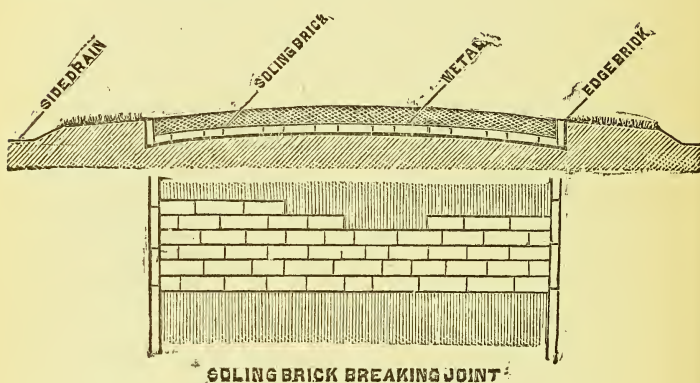


turfed, as slopes so protected will last for years without repair or attention. Cutchia roads should not be made too wide, as the wider they are the greater will be the cost of maintenance; 20 to 25 feet will be found a sufficient width as a rule. If I were asked to define a perfect road, I should say that it is one the course of which is perfectly straight, its line perfectly level, and its surface as hard, smooth, and non-elastic as possible.

A well-constructed jhama road when kept in proper order and watered during the hot months to keep down the dust, is one of the most pleasant forms of roadway for horse and carriage traffic imaginable, but for heavy cart and waggon traffic it is hardly sufficiently durable. What is known as jhama, is hard well-burnt brick partly fused or vitrified by the action of the fire. Good well-burnt jhama breaks with a clean sharp fracture, does not pulverise to any appreciable extent, and packs close and firm on the road surface. It should be hard, heavy, of a dark red color, running into *blue* in parts, with a clear metallic ring when struck with a hammer. Overburnt jhama becomes porous, honey-combed, and mixed with scoriæ, and is sometimes so light as to float when thrown into water; this is useless for road-making. First class road metal should consist of about 75 per cent. of jhama of the kind above described, the remainder consisting of sound well-burnt brick.

All *amah*, or soft brick, and *peelah*, or unburnt stuff, should be rejected. In making a new road, the surface of the ground should first be cut to the proper level and section, and with a slight rise to the centre of the road. The whole surface is then laid with bricks flat, called the soling. Soling bricks should be laid by a bricklayer, or

other workman accustomed to the work, and should break joint over the whole surface so as to make a firm

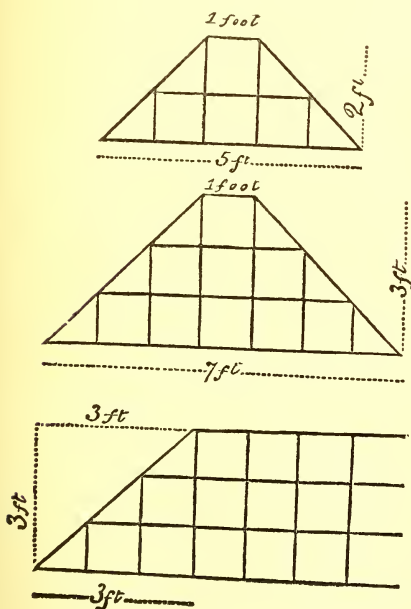


stable foundation. Over this soling is laid the jhama broken to a size which will pass through a ring of two inches diameter. It is to be laid to a depth of five to eight inches, and to an equal depth all over, but with a slight rise to the centre of the road. The jhama after being raked over is handpacked, all large lumps being broken with the hammer; the whole surface is then rolled with a one-ton to two-ton roller, plenty of water being sprinkled over the surface throughout the rolling. When sufficiently consolidated, which can only be judged by practice, an inch of good dry kiln or building rubbish is spread over the surface, which is again watered and rolled till a thoroughly hard even surface is the result. Plentiful watering during the rolling is a *sine qua non*. The person supervising road construction should never allow rubbish as binding to be put over a road until he has satisfied himself that the metal has been properly handpacked and sufficiently consolidated. Contractors

and underlings will hurry on the binding, or as it is not inappropriately termed sometimes, *blinding!* material to conceal defects.

As jhama metal is usually broken on the side of the road to be repaired, it should be stacked in uniform continuous stacks, and the person responsible should satisfy himself by measurement that the full quantity of metal contracted for has been supplied before any spreading is permitted. For example, say the length of road to be metalled is 3,000 feet, and the width 12 feet, with a depth of metal of 6", the metal, if stacked continuously, would measure in stack, length, 3,000 feet; cross section, width of base 5 feet; width at

top, 1 foot; height, 2 feet; sectional area, 6 square feet; contents, 18,000 cube feet; but as it is in practice usually impossible to stack metal in an unbroken line on account of cross-passages, gateways, house entrances, trees, and other obstructions, it is more convenient to put it up in stacks of, say 20 feet long. Eighty-eight stacks of the following dimensions will give 18,000 less 48 cube feet:—



Length of base, 20 feet; length of top, 14 feet; height, 3 feet: cross section, width of base, 7 feet; width of top, 1 foot; height, 3 feet; sectional area, 12 square feet; contents, 204 cube feet. The diagrams in the margin will show this clearly, the following being the mode of calculation:—

$$20 + 14 = \frac{34}{2} = 17. \quad 7 + 1 = \frac{8}{2} = 4.$$

$$17 \times 4 = 68 \times 3 = 204.$$

The same principle applies to roads of any dimensions, but it will be found convenient to have a standard measurement and supply the contractor with a wooden gauge.

In repairing or remetalling old roads, the surface of the road is to be well picked up and levelled, so that the new and old metal may bind properly: no part of the old metal should be removed and used as binding for the new layers.

A well made jhama road, laid with good picked material, should last without repairs, subject to ordinary town traffic, for three seasons: this, however, depends on the quantity and class of traffic.

Stone roads, or what are often called Macadamised roads (after Macadam, one of the first constructors of modern roads with broken stone), are laid with indigenous stone or ship's ballast broken into irregular cubes so as to pass through a ring of two inches in diameter. In Calcutta and its neighbourhood the stone used is either brought from Oodooa nullah in the vicinity of Rajmahal, and excavated from the low spurs of the Rajmahal Hills, or is ballast from Bombay, Melbourne or

Mauritius. Laterite is much used in Madras, but is too soft to stand much traffic. Granite, trap, and hard limestones are the best kind. All stone roads should be laid upon a foundation of stone boulders, or, where they are not procurable, on a well-laid soling of sound hard bricks. A stone road made without soling, though it may be, to all appearance, a hard sound road, will never bear heavy traffic, the subsoil will yield more or less under the superincumbent weight, and in long continued wet weather, especially with the tremendous tropical downpour of these latitudes, the mud will work up to the surface and the road will speedily become impassable. I do not overlook the fact that Macadam maintained that no foundation of large stones or other material was necessary even in the softest soil, but recommended that the foundation be made of broken stone the same as the surface.

Where a good foundation of boulders has been first laid, a six-inch layer of broken stone will form a good lasting road; but where bricks are used over a soft subsoil, at least eight to nine inches of metal will be necessary at first construction to ensure a good trafficable road. The amount of traction power required varies very considerably on roads of different construction, and is much less in proportion to the strength and hardness of the surface.

It has been proved by experiment that, "on a well made pavement, the power required to draw a wagon was 33 lbs.: on a road made with six inches of stone of great hardness laid on a foundation of large stones, the power required was 46 lbs.: on a road made with a thick coating of broken stone laid on earth, 65 lbs., and on a gravel road laid on earth, 147 lbs."

Stone for road-making must be broken into sharp

angular forms. They then wedge together into a hard compact mass. According to Macadam no binding material should be used, but in this country the use of binding is universal, and care must be taken that the binding used is good dry brick and lime rubbish without any admixture of earth or clay, which would make the road muddy during rainy weather, or where streets are copiously watered. The transverse section of the road should be gently convex. As footpaths are seldom used in this country, pipe drainage is not required; but there must be provision for letting the surface water pass freely into the side drains, which should be of sufficient depth to drain not only the surface but the whole formation. It should always be borne in mind that the best stone,—that is to say, the hardest and toughest,—though perhaps more costly at the outset, is the least so in the end. The best material for stone roads, as before noticed, is tough granite. Water is the worst enemy to good roads; it is therefore one of the first principles of road-construction that they should be kept dry; no water being allowed to lodge on the road surface.

A useful material for raising and metalling lanes and byroads, where there is little traffic, is often available in towns where any large manufactories, mills or foundries exist, in the slag, cinders, ashes, and scoriæ from the furnaces.

In some parts of England, and on the Continent of Europe, as in Silesia, slag is largely used in road-making. It is not available, however, in sufficiently large quantities here to make it of value for that purpose, but occasionally sufficient quantities of it, mixed with ashes and cinders, are procurable in suburban districts, to form a dry

substantial surface to small lanes and footpaths. It merely requires to be laid on the road surface, levelled and rolled with a light roller. Where there is little or no wheel traffic, it will last with a little attention for a long time, and add greatly to the comfort of the residents at a very small cost.

During the hot weather the stone composing road surfaces is very apt to work loose: all loose stones should be gathered up and removed, as they are not only likely to throw horses down or lame them, but each stone, as a heavy wheel passes over it, acts as a pick to loosen others, the mischief thus repeats itself, and the road, if neglected, soon becomes almost impassable. Great economy will result from a regular attention to, and immediate repair of any small portion of road surface which has worn out.

There is some difference of opinion as to whether trees are beneficial or hurtful to road surfaces. Some authorities consider that where trees are planted close to and overhanging a road, the droppings from the leaves injure the surface, and their shade keeps it from drying properly.

Others consider that they do more good than harm, by protecting the surface from extreme heat. I think that if the undoubted comfort to the wayfarer be added to the probable benefit, the balance is in favor of planting trees, so as to give the greatest amount of shade with the minimum of obstruction to traffic. American engineers hold, that shade is objectionable on earth roads though admissible on stone roads, and their objections, so far as they go, have reference more to the exclusion of the sun from the road surfaces in winter, when the roads are dangerous and slippery from frost, than to any other question.

The metalled portion of a road should not be less than sixteen feet, to allow vehicles to pass each other with ease.

Although probably few Municipalities have to undertake extensive works of this class, it may happen that those situated near the sea-board, or contiguous to the large tidal rivers, may require protective works of the kind, and a few words on the subject of constructing, protecting, and maintaining embankments may therefore not be out of place.

Whilst engaged in the construction and maintenance of such works, and the reclamation of tidal lands at Port Canning and in the 24-Pergunnahs, Sunderbunds, I had exceptional opportunities of studying the system of embanking them in vogue and in detecting its faults and weaknesses, and an improved system was introduced by me in the works under my charge, with great advantage.

The common faults were: the construction of embankments with insufficient slopes, especially on the river face; the digging of the earth required for the construction from irregular holes or pits (locally termed *chokats*) from both sides of the embankment indiscriminately; and the throwing up of long lengths of rough embankment without beating, ramming, and consolidating the material whilst moist and plastic. The evils resulting from these errors were: first, the erosion and instability of the embankment from insufficient slopes; secondly, the holes from whence the earth had been dug being below high water level, the earth was kept constantly moist and soft, mud crabs burrowed freely through the softened base of the embankment, there was continuous percolation backwards and forwards as the tides rose and fell, and the embankment being thus rendered unstable, settled, and cracked, leaked,

and finally gave way, or was breached by the spring tides ; thirdly, the stiff alluvial earth being cut in plastic lumps was thrown together to form the bank, and when these lumps were exposed to the sun and air, they quickly dried and hardened, forming hard clods, which could not be afterwards made to pack or lie close, the embankment was thus full of hollows, and these admitting the water, formed leaks and fissures, which soon caused its destruction. We will now consider how an embankment ought to be made. No particular form or dimension can be insisted upon for general adoption, as the necessities of each case, and the forces which the embankment will be required to withstand, must determine these points ; but it may be accepted as a first principle, that where the bank is formed of sand, as light sandy soil, the sea or river face must have a sufficiently long slope to receive and deaden the force of the waves as they traverse its surface, and that to oppose, an abrupt slope to receive the shock of the waves or the constantly eroding action of a strong tide or current, would be to court the destruction of the embankment. The height of an embankment must entirely depend on the maximum height of the tides calculated at the highest springs, and no rule as to height can therefore be given ; the top of the bank, however, should never be less than two feet higher than the highest known rise. A good form of embankment for a four-feet high bank is a base of twenty-four feet, top four feet, external slopes three to one, and internal slopes two to one ; where the material is sandy, the outer slope may, with advantage, be increased to three and-a-half to one, and the inner slope reduced to one and-a-half to one.

Where, on the other hand, the material is sound and durable, as it usually is in the case of salt marshes, the outer slope may, with safety, be reduced to two to one, the base of the embankment being thus reduced to eighteen feet.

The material for the construction of the embankment should never be taken from holes or chokats on both sides of the bund; it may be taken from the main ditch or drain within the embankment, or be taken from cuttings along the foreshore. In the latter case the high tides which flood all the land outside the embankment would deposit so much silt, that these holes or cuttings would soon be entirely filled up, this silting up being greatly facilitated by planting brushwood spurs diagonally across the foreshore. In this manner the whole of the land outside the bank would be gradually raised, thus adding greatly to the stability of the work. The great benefit to be effected by the use of simple means, like the planting of brushwood spurs, is not sufficiently appreciated or understood, but I have seen large gaps in river banks, and the mouths of very large reclaimed creeks, made up by this very easy and inexpensive expedient. It is well known that large rivers like the Ganges and its affluents running their course through alluvial soils, bring down in suspension vast quantities of mud and silt, especially during the rains. This is carried out to sea, and aids in the formation of those dangerous bars and shoals at the entrance of the deltaic rivers called the Sandheads; but it is not, I believe, so generally recognized, that the floodtides bring back a very large quantity of this silt. This, so long as the tide is running, remains and is carried along in suspension; but when the force of the tide is spent, and what is termed the period of

slack water occurs, the mud and silt rapidly subside, and if not exposed to the scouring action of the ebb, gradually raise the ground where they are deposited. The unvarying law of the currents aids this process, for the floodtide rushes over the shallows, but the ebb water subsides gently off the higher ground and seeks the deep channel, where its scouring action is, therefore, greatest. The spurs act by intercepting the silt, breaking the force of the current, thus causing more rapid subsidence and lessening the scour. The third point referred to is faulty construction; this can only be avoided by constant and intelligent supervision, by insisting on every length of the embankment being well packed, rammed, and beaten into a solid homogenous mass before the clay has lost its plasticity by drying and hardening, and all fissures caused by the sun-drying and cracking the bank, being carefully filled and rammed, water being added, if necessary, to moisten the earth. All embankments should, when completed, be well grassed or turfed to preserve them from the effects of the weather and the erosive action of water; the best grass for the purpose is the common *dhoob* or *doorva* (*panicum* or *cynodon dactylon*), which, when once fairly established, is almost irradicable, and forms a fine close-matted covering to the bank and yields an excellent fodder. It is easily planted either by dibbling in small rooted tufts three inches or so apart, or by chopping up a large quantity of the roots and jointed stems, mixing them with a puddle of clay and cowdung, and plastering the mixture all over the bank. A few coolies, or even old women and children, can thus cover a very large surface at small cost, and if done in the rains, three weeks or a month will suffice to cover

the whole surface with a fine growth. Of course turfing or sodding makes a closer, stronger turf in less time, but it is much more expensive, and sufficient turf is not always procurable. Stone or shale will seldom be available; but where it is, it may be used for facing the bank to great advantage. All sea and river embankments require constant watching to prevent and remedy the perforation of the banks by rats, crabs, and other burrowing vermin. Crabs do an immensity of mischief to the cultivators' bunds, and the Government embankments in the Sunderbunds and the 24-Pergunnahs. An embankment must be kept perfectly impermeable to water, a rat-hole or crab burrow (or ghogue, as it is locally termed), though apparently of little consequence at first, if unattended to, will be the sure precursor of a breach.

This danger can only be guarded against by constant inspection and by keeping (bildars) or working patrols constantly traversing the embankments and stopping the holes and repairing weak places.

In America, in the reclamation of marsh lands, great difficulties have been experienced from the destructive ravages of muskrats, and in many cases attempts at reclamation were entirely defeated by these persevering and destructive rodents, who bored through the embankments between high and low water mark. In the reclamation works at Newark Meadows, New Jersey, this difficulty was at last overcome by the insertion in the heart of the embankment of iron dike-plates or cores, covering the space between high or low water mark. Such a material would probably be found too expensive for ordinary use, but where common timber is plentiful, a dike core of wooden slabs might be used with advantage.

Where any portion of an embankment is greatly exposed to the wash of the sea or river, it may be protected from erosion by facing it with a layer of brushwood or reeds tied in bundles. Standing brushwood and trees on the outside of the embankments should also be preserved, and not cleared away, as is too often done; they form an efficient breakwater; such trees only should be cut which, being situated right on the edge of the foreshore, are, if the bank be abrupt and broken, liable to be blown down and thus aid in destroying the bank by the leverage of their roots.

Cattle should be carefully kept off newly-formed embankments, though the constant passing of foot-passengers along the top of the bund helps to consolidate the earthwork.

Always keep in mind the stringent necessity of at once repairing the smallest leak and making up the smallest sinking or depression. A rat-hole or crab-burrow filled up as soon as discovered, or a spadeful of earth applied in time, may save acres of standing crops and many hundreds of rupees worth of valuable property from destruction, as well as avert danger to the health of the people, from brackish inundation, and consequent death and decomposition of vegetable matters.

It is not within the scope of this work to enter into elaborate details of building operations or attempt a treatise on brickwork, but a few practical hints may be of use to unpractised and nonprofessional readers in carrying out and superintending minor necessary buildings, such as drain bridges, retaining walls, sluices, office buildings, or the like. It rarely happens now-a-days that any important Municipality or large civil station is

without a professional engineer, connected either with the Public Works, Road Cess, or Municipality, but it may, nevertheless, fall to the lot of others, as it has to mine, to superintend the construction of even large buildings, and bridges over considerable streams, without professional assistance, and as native contractors (like their confraternity all over the world) naturally seek to make the largest possible profit; and as native workmen, when not looked after, are sure to scamp work, a little knowledge of how work ought to be done will never be thrown away. The manner in which bricks are laid is termed bonding, and may be either what is termed old English bond or Flemish bond. In English bond, alternate courses of bricks are laid lengthwise with the length of the wall, and which are technically called stretchers, crossed by other courses in the thickness of the wall termed headers: bricks must always be so laid as to break joint; this is managed by the use of what are termed *closers*, *i.e.*, bricks cut in two longitudinally, or transversely into four parts, one of these being placed next to and inside the first header from the end or corner of the wall. Flemish bond is made by placing a stretcher and a header alternately in the same course; for unplastered work it has a prettier appearance, and for walls one and-a-half brick thick is the most convenient bond, but it has not the strength of English bond, and is apt to split on any settlement taking place. Bricks must not be laid too close together, as there will not in that case be a sufficiency of mortar to make solid work. The joints should be $\frac{3}{8}$ ths of an inch wide, and should be thoroughly well filled in with mortar. Bricks should be well soaked in water for at least an hour before they are

wanted for use, otherwise they abstract the moisture from the mortar and destroy its adhesive properties; and sufficient water should be used to keep the mortar plastic and the work moist, but not enough to wash the mortar out from between the joints. Every brick should not only be laid in its place, but should be rubbed and pressed down so as to force the mortar into the pores of the brick and secure firm adhesion. Bricks used in first class work should be of uniform size, sound and well burnt, straight and well shapen; a good brick gives, when struck with a hammer, a clear ringing sound. The mortar used should be one part pure fresh lime to two parts of soorkee made from well burnt or vitrified bricks, ground and screened through a soorkee screen with four meshes to the linear inch; the proportion of mortar used should be about 24 cubic feet (measured dry) to the 100 cubic feet of brick-work.

The courses of brick-work should be laid in regular straight lines, with a slight inclination of the bricks towards the middle of the wall, that one-half of the wall may act as a shore to the other half. Wall faces must be perfectly true and plumb; every course must be thoroughly grouted, *i.e.*, well filled in with wet mortar, and the top of unfinished work should have a single brick built round and flooded with water or well moistened, and covered up with mats, palm leaves, straw, or the like, to prevent its drying too quickly. Good strong lasting masonry will never be obtained if the work is allowed to be baked up by the midday sun, or the lime washed out of the upper courses by heavy rain.

Arches require special care; they should, as a rule, be turned over properly-constructed wooden centers; but in

India and in ordinary work, centers are generally constructed with dry bricks and clay, the upper surface being plastered with clay and worked to the exact shape of the intrados, or soffit, that is to say, the underside of the arch: after this has been sanded over and allowed to dry, it is ready to build upon, and answers its purpose sufficiently well for ordinary work. The bricks are laid in concentric rings, on edge, the joints radiating truly from the center, the bricks firmly set with a mallet, and the joints carefully and thoroughly filled in with fine mortar and not more than quarter of an inch wide, the lower edges touching each other. In small arches the centerings may be struck as soon as the arch is completed, but in large arches it is necessary to give time for the mortar joints to set and harden before withdrawing the support of the centering; an arch should not be built upon until it has settled to its proper bearing.

In buildings where there is any fear of settlement and in wing walls and curtain-walls to bridges and sluices, the foundation should be laid on concrete, and in some cases piling may be necessary. Additional strength will be given by introducing hoop iron flatwise into the bond: the iron if slightly rusted, or the edges notched, will adhere better to the mortar; this adds little to the cost of the work but greatly to its stability. A large outfall sluice constructed some years ago (about 1869) on the banks of a tidal river and on a most treacherous foundation full of springs and quicksand, in which hoop-iron bond was introduced, has never since shown the slightest sign of fracture or settlement, although the structure it replaced had been twice carried away in the course of five or six years.

CHAPTER XXI.

“The horse, as at present treated, is the victim of ignorance, and is exposed to every abuse. Its welfare is secondary to the convenience of the master, and its custody is transferred to the unscrupulous cupidity of the servant.”—*Mayher*.

The provision, feeding, and treatment of conservancy cattle is so often a source of trouble, that a few words on the subject may be of use.

The procuring of suitable cattle for conservancy work is becoming a serious difficulty in Lower Bengal, where there is no question that the breed of cattle is fast deteriorating. Of late years, owing to the influence of repeated famines, cyclones, the ravages of cattle epizootics, and the demand for transport purposes, created by the constantly recurring frontier wars, the difficulties in the way of procuring bulls, bullocks, and ponies have largely increased as well as their prices. A few years ago Brahminee bulls were so common as to be sometimes a serious annoyance in the villages and bazars. Now-a-days they are seldom procurable. The draught and plough cattle are small, light-boned, thin flanked, coarse-bred, and poor in flesh, unable to stand any heavy work and peculiarly susceptible to disease: in price they average from Rs. 25 to Rs. 35 each; but out of a collection of two or three hundred at any of the local cattle markets or

hauts, there are seldom a dozen to be found fit for conservancy work.

Ponies also are scarce and very inferior. The old stamp of country pony with a hill cross, short in the cannon bone and pastern, with flat legs and hard round feet, broad in the quarters, short and deep in the barrel, with stout crest and rather low thick shoulder, is now hardly to be found. Eight or ten years ago, after the Sonapore fair, I could pick up fifteen or twenty good ponies at reasonable prices, Rs. 40 to Rs. 45, at the Chitpore horse-marts any morning in the cold weather. Now, one may search the whole range of stables and not find five fit for cart-work, and those at three times the price. Further up country, no doubt, the difficulties are less. Close to Calcutta there are the three large Municipalities, the demand for hackney-carriage-cattle, and the requirements of numerous building and other contractors to swell the demand and raise prices.

For conservancy carts I much prefer ponies to horned cattle: they work quicker, draw better, last longer with ordinary care, and are much less subject to disease.

Mules, though strong quick workers, are troublesome and vicious. They fight in the yard, and are apt to bolt with the carts: they are also not so well fitted constitutionally for work in a damp hot climate. Buffaloes, though strong and hardy, are slow, lazy, and troublesome. Conservancy ponies get but little grooming or attention, nor do they, as a rule, require very much, though they should always be rubbed down on their return to the depôt, and the mud and dirt cleaned from their legs, and legs and feet dried. They require to be well housed and well fed: Close stables are unnecessary; but a good water-tight

thatched roof over them, and a hard dry floor under them, is essential for keeping them in health. Nothing is better than a well-made asphalted floor, with just sufficient slope, to prevent wet and urine from lodging about their feet and bedding. Every pony should have a blanket for the cold weather.

The ponies should be carefully examined by the overseers or other persons in immediate charge daily, to see that they are properly looked after, and are not worked with abrasions, saddle-galls, or sitfasts. Conservancy carters are a thoughtless, careless class, and will work cattle with deep sores sooner than report the matter. Harness should be carefully attended to, a badly stuffed or dilapidated saddle pad or collar is certain to result in a soreback or galled shoulder, not only causing needless suffering, but often laying up an animal for weeks. There are several forms of saddles and pads, but whatever form is used, care must be taken to see that it is always kept clear of the dorsal ridge, otherwise not only bad sores, but serious injury to the spine, may result.

The first appearance of a soreback is generally a small hardish swelling, tumour, or warble, and this, if neglected, will soon run into a serious, and perhaps irremediable, gall or a *sitfast*, requiring the use of the veterinary surgeon's knife for its removal and cure. On the first appearance of a warble, the back should be well and repeatedly washed with a strong solution of salt and water, the pony put off work for a day or two, and the saddle pad carefully examined and re-stuffed, if necessary, leaving a hollow in the stuffing over the tender part. A common habit of the carters must be watched for and checked by admonishment and fine, *viz.*, riding on their carts—usually

on *one shaft*. This drags the weight unequally to one side, and is sure to gall the pony. After emptying the contents of the tip carts, the men constantly let the body of the cart fall back to its place on the shafting, instead of lowering it down by hand. This not only knocks the carts to pieces, but is apt to *shock* the ponies' spine and cause *chink* or ricking, and consequent paralysis and ruin to the animal.

Regular and careful shoeing must not be overlooked. Whenever a pony presents any appearance of sickness, such as dullness of eye, drooping of the head, staring coat, refusal to feed, running at the nostrils or swelling of the glands under the jaw, it should at once be segregated from the rest and kept under treatment and observation; its bedding should be burnt, and its bucket or feeding bag removed with it. In every depôt there should be a separate shed as far from the general shed as possible for keeping sick or suspected ponies when glanders or farcy are suspected. The advice of a veterinary surgeon should at once be obtained; but where none is available, the officer in charge must do his best. It does not follow that, because a pony has a profuse muco purulent discharge from the nostrils, with considerable swelling of the glands, that it is suffering from glanders; these appearances may probably be only the results of a bad cold neglected, and the swelling may, in young ponies, be the accompaniment of strangles, a troublesome but not dangerous disease. A warm shed, plenty of bedding, bran mashes, a stimulating lotion or liniment well rubbed into the glands round the throat and up to the roots of the ears, and steaming the nostrils with boiling water poured over some hay in a bucket, with the addition of

spirits of turpentine, and a tonic, will generally effect a cure. If the disease be pronounced glanders, the animal must be destroyed, and the carcass buried in quicklime, the skin being slashed, and all bedding, blankets, rollers, and other things belonging to it burnt. The zinc bucket and iron bits may be thoroughly disinfected by burning. Lampas is a common complaint: it is a swelling of the bars of the upper part of the mouth: it is seldom of much consequence, but prevents the pony from eating his corn, and so reduces its strength. A slight scarification of the bars with a sharp penknife, and a little salt rubbed in, will generally effect a cure. Feeding must be carefully attended to, and care taken that the carters do not sell the food, or feed goats and rams with it. Three seers, or six pounds, of crushed food, with twenty bundles of hay and a small quantity of green grass, lucerne or guinea grass, is sufficient for an ordinary pony. When ponies are low in flesh or out of condition, a few pounds of carrots daily will be found a valuable restorative, and a spoonful of the following mixture in their feed will have a marvellous effect:

Ujwein, two pounds.

Sulphur, two pounds.

Black salt, two pounds.

Soormah (black antimony), one tolah.

These ingredients to be separately pounded fine, intimately mixed, and kept in a tin in a dry place.

Bullocks should be fed with peas, chopped straw, and oilcake. A mixture of peas crushed, wheat bran, Indian corn, and oilcake is sometimes given; but I prefer the broken peas mixed with finely cut straw and oilcake

and sufficient water to wet the mass. All cattle are kept in better health if allowed to graze occasionally where grass land is available, but bulls must not be turned loose to pasture, as they fight and injure each other.

When bulls are restive and troublesome in the carts, the cart-drivers sometimes have a trick of blinding them by putting the milky juice of the ranga chittra, or one of the euphorbias, in the eye. This causes a dull white opacity of the eyeball, completely obscuring and ultimately destroying the sight. It may be cured, if not of long standing, by a mild lunar caustic lotion, covering the eyes up, and sponging them with a decoction of poppyheads.

GLOSSARY.

Abdar	... A domestic servant in charge of drinking-water.
Abdarkhanah	... An apartment for the storage of drinking-water.
Adhygunga	... The original course of the Ganges.
Âm	... Mango.
Âmah	... Soft or badly-burnt brick.
Amultas	... The Cassia fistula.
Asôc	... The Jonesia Asôca.
' Atcha, kal korebo '	... Very good, to-morrow I will do it.
Austakoor	... A pit for deposit of household refuse ; a midden.
Baêr	... The Zizyphus jujuba, or native plum.
Bân or bain	... A common jungle tree (Avicennia tomentosa).
Bazaar	... Market ; native business quarter, or quarter inhabited by camp-followers.
Bhagirutty	... The sacred stream of the Ganges.
Bherinda	... A common weed ; a species of euphorbia.
Bhîtá	... A homestead site.
Bhisty	... A Mahomedan water-carrier.
Biggah	... A land measure ; third part of an acre.
Bilaëtie or velaitee	... European.
——— tentool	... European tamarind (Adansonia).
——— gab	... European gab (Diosperos kaki).
Bildar or beldar	... A native working patrol, employed on embankments, &c.
Bôn or bûn	... A thicket, wood, forest, jungle, wild.
Bon-kochu	... The wild arum ; a common ditchside weed.
Bokool or bokul	... The Mimusops elengi.
Bôr or bûrr	... The Ficus Indica.

Boistum or Vaishnav	... The worshippers of Vishnu.
Bokra (see Hentâl)	... The Phoenix paludosa; Sunderbund shrub, wild salt water date.
Bokra bon	... A thicket of bokra.
Boxwallah	... A peripatetic vendor of sundries; a hawker.
Brahmun	... A Hindu of the priestly class.
Brahminee bull	... A bull dedicated to the deity.
Bukayen	... Melia sempervirens.
Burgah	... A rafter.
Bustee	... A village, a collection of huts, a native quarter.
Chaltâ	... The Dellenia speciosa.
Chamâr	... A low caste of the Hindus; leather dressers, curriers, tanners, shoemakers, &c.
Champâ	... The Michelia champaca.
Chingree	... A species of prawn.
Chowkâts	... An earthwork measurement $4' \times 4' \times 4'$, also the four sides of a door or window frame.
Chundi-mundop	... The house of the Goddess Chandi, or Durgah, a public sitting room or reception hall.
Chudder or châdar	... A sheet or covering for the body.
Coolie	... A laborer.
Cottah	... A land measure, the 20th part of a biggah, or 60th part of an acre.
Culchi	... A common porous earthenware jar.
Cutchâ	... Unripe, unfinished, unbaked; used in building or with reference to material to signify unbaked or sun-dried bricks and clay mortar.
Cutchâ-pucka	... Half finished work, or work done with pucka or burnt brick, and inferior or clay mortar.
Dalpoorie	... A coarse cake made of dal, rice, and goor.

Debdaru or devdara	... The <i>Uvaria longifolia</i> .
Desee badam	... The country almond (<i>Terminalia catappa</i>).
Dhangur	... A laboring class, native of Chota Nagpore.
Dhobee or dhopah	... A washerman.
Dhoob or doorva	... A common grass (<i>Cynodon dactylon</i>).
Dome	... A low caste of the Hindus, attendants at the burning ghat; carriers of corpses and carcasses; basket-makers.
Dooars	... A tract of country at the foot of the Himalayas.
Dosadh	... A low caste of the Hindus; breeders of pigs.
Ghat	... A landing place; a flight of steps down to the water.
Ghogue	... A crab-hole, or leak in an embankment.
Gointah	... A cake of dry cowdung for fuel (<i>Bois de vache</i>).
Goleputta	... A large leaf used for thatching (<i>Nipá fruticans</i>).
Goolar	... A wild fig (<i>Ficus guleria</i>).
Goor	... Molasses.
Goran	... A wood used for posts or fuel (<i>Rizophora decandra</i> , or <i>Cerriops Roxburghianus</i>).
Gowalla	... A milkman or cow-keeper.
Goal or gowalghur	... A cowhouse or <i>byre</i> .
Gowalpara	... A village or quarter inhabited by milkmen.
Gulab-jam	... The rose-apple (<i>Jambosa vulgaris</i>).
Gullie	... A narrow lane.
Gunga	... The river Ganges.
Guramie or ghorami	... A thatcher or hut-builder.
Hallalcore	... Nightmen or scavengers in Bombay.
Hari	... A nightman or sweeper caste of Bengal.

Hât	... A periodical market.
Hentál or hurtal (see Bokra)	... The wild salt water date (<i>Phoenix paludosa</i>).
Hela	... A nightman or sweeper caste of Bengal.
Hingool	... Artificial cinnabar ; vermilion.
Jalla	... A large porous earthenware jar for water, grain, &c.
Jamrool	... The star-apple (<i>Jambosa alba</i>).
Jarool	... The <i>Lagerstræmia regina</i> .
Jemadar	... A native officer ; an overlooker over coolies.
Jhama or jhama khoah	... Well burnt or vetrified brick for road-making.
Jhangra	... A bivalve found in the Sunderbund creeks.
Jheel	... A swamp or large piece of water.
Jhinak	... A salt water shell found in the Sunderbunds.
Jullah	... A swamp or morass ; lowlands under water in the rainy season.
Jungle	... A forest, thicket, wild plants, and weeds.
Kachhi	... A low caste cultivator, North-West Provinces.
Kadam or kuddum	... The <i>Nauclea kadamba</i> .
Kálábosh or kulboush	... A tank-fish of the carp species.
Kasia багаun	... From Kasia, Kesia or Kâsh (<i>Saccharum spontaneum</i>), a tall species of grass used in certain religious ceremonies, and Bagaun, a garden.
Katla or cutla	... A large tank-fish of the carp species.
Kardahi	... A flowering shrub (<i>Grislea tomentosa</i>).
Kashi	... The <i>Erythrina Indica</i> .
Kela	... The plantain or banana.
Kintal	... A collection of huts inhabited by the poorer Portuguese and Eurasians in Calcutta.

Khoah	... Broken brick for roadmaking and concrete.
Kunker	... Nodular limestone.
Kuntal	... The jack tree (<i>Artocarpus integrifolia</i>).
Kúthbél	... The wood-apple (<i>Feronia elephantum</i>).
Leep	... To plaster with clay and cowdung.
Maidan	... A plain ; open grass land.
Mali	... A gardener.
Malpowa	... A coarse cake or sweetmeat.
Mâtâm	... A level, mark, or bench-mark.
Mehter	... A sweeper or nightman.
Mirgal	... A tank-fish of the carp species.
Mofussil	... The country as distinguished from the town.
Mohullah	... A quarter or division of a town.
Moordafarash	... A carrier of corpses.
Moripora Brahmun	... A degraded priest who performs muntras or ceremonies at the cremation ground.
Motu or mootho	... A coarse species of grass (<i>Cyperus hexastachyus</i>).
Mundul	... A village headman, also a family name.
Munkir and nakir	... The two interrogatory angels who question the soul of the departed Mahomedan.
Murum	.. A kind of earth or gravel.
Mussuck	... The goat skin bag in which the Mahomedan water carrier or bhisty carries water.
Nalla or nulla	... A stream or creek
Nand	... A common earthenware tub.
Nakir	... <i>See</i> Munkir.
Neem	... The <i>Melia azad</i> .

Ooloo	... A coarse grass, used for thatching (<i>Imperata cylindrica</i>).
Paddy	... The rice plant; rice before being husked.
Pagár	... A ditch and bank dividing two plots of land.
Panna	... Cryptogamic water plants; Algæ.
Peelah	... Unburnt, yellow, unbaked brick.
Peon	... A messenger; a gangster over coolies.
Pipal or peepul	... The <i>Ficus religiosa</i> .
Pucka	... Well built; built with burnt brick and mortar.
Pudma or puddo	... The lotus or water bean (<i>Nelumbium speciosum</i>).
Pyara	... The guava (<i>Psidium guajava</i>).
Raiyat or ryot	... A peasant, cultivator, tenant.
Ranga chittra	... A common hedge plant; a species of euphorbia.
Ruho, rooie, or rui	... A tank-fish of the carp species.
Saigoon	... Teak (<i>Tectona grandis</i>).
Seemul or simul	... Cotton tree (<i>Bombax heptaphyllum</i>).
Shah	... <i>Acacia catechu</i> .
Shankari bazar	... The bazar or quarter of the shell-cutters.
Shastras	... The books of the sacred Hindu law.
Singhara	... The water chestnut (<i>Trapa bicornis</i>).
Sissoo	... <i>Dalbergia sissoo</i> .
Siriss	... <i>Acacia sirissa</i> .
Soondry	... <i>Heritiera littoralis</i> .
Soormah	... Black antimony.
Soorkee	... Pounded brick used for making mortar.
Sundaish	... A well privy.
Sunderbunds	... The forest of the Gangetic Delta.
Tacca	... Rupee; current coin.

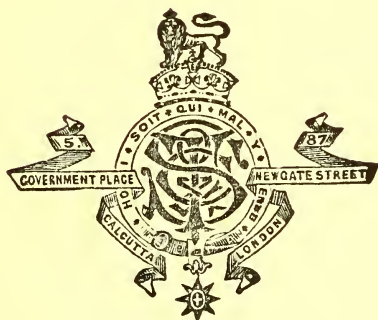
Taccus	... Tax, an adaptation of the English word.
Tâl	... A common palm in Bengal (<i>Borassus flabelliformis</i>).
Tentool	... Tamarind (<i>Tamarindus Indica</i>).
Teraie	... The land skirting the base of the Himalayahs.
Thacoorbattie or thacoorbari	... The house of the Thacoor or God.
Ticca-garrie	... A hired carriage, the cab of the East.
Tikra	... The coarse earthenware rings used for lining wells in sandy or alluvial soil, a potsherd.
Ujwein or ajowan	... The aromatic seed of an umbelliferous plant, the <i>Ptychotis ajuwan</i> , which yields Thymol.
Zemindar	... A landholder, landlord.

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